United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Minnesota Agricultural
Experiment Station

Soil Survey of Todd County, Minnesota

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How To Use This Soil Survey

General Soil Map

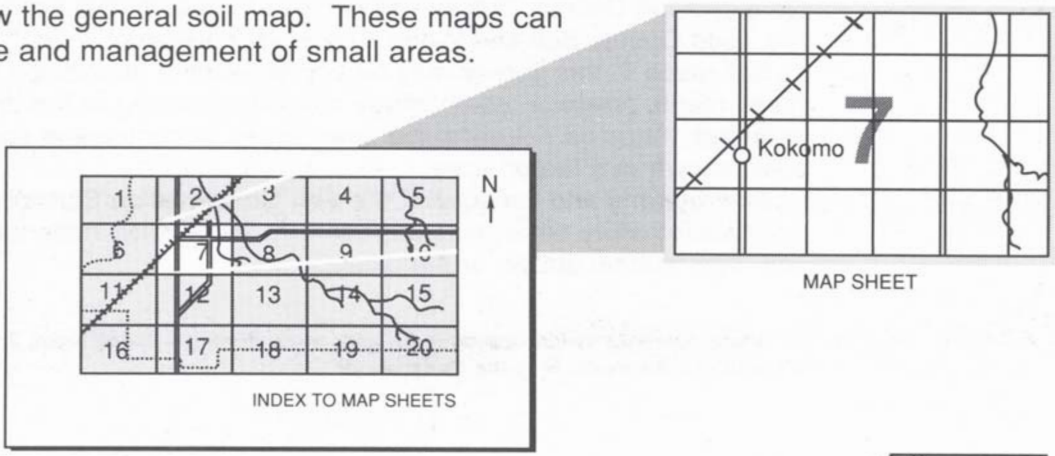
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

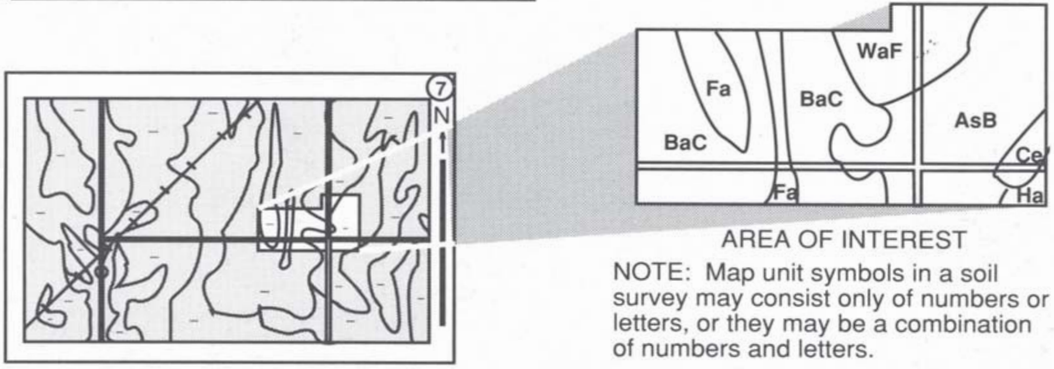
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It was partially funded by the Legislative Commission for Minnesota Resources and by Todd County. Other assistance was provided by the Minnesota Agricultural Extension Service, the Minnesota Board of Soil and Water Resources, and the Todd County Soil and Water Conservation District. The survey is part of the technical assistance furnished to the Todd County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Contour stripcropping in an area of Holdingford sandy loam, 2 to 6 percent slopes. An area of Rifle muck is in the foreground.

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Foreword

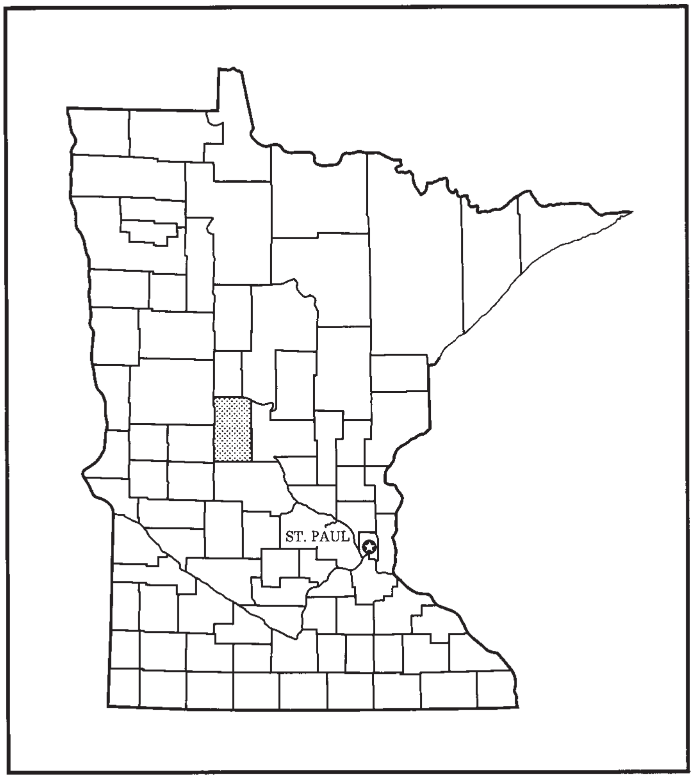
This soil survey contains information that can be used in land-planning programs in Todd County, Minnesota. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Gary R. Nordstrom
State Conservationist
Soil Conservation Service



Location of Todd County in Minnesota.

Soil Survey of
Todd County, Minnesota

By Charles T. Saari, Soil Conservation Service

Fieldwork by Michael L. Lieser, Ward J. Aas, Jerome F. Gorton, Kim D. Steffen, and Charles T. Saari, Soil Conservation Service; and Tom Groth, Patrick C. Hanson, Donald Jossie, Kermit E. Larson, Douglas E. Miller, and James R. Orr, Minnesota Agricultural Experiment Station

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Minnesota Agricultural Experiment Station

General Nature of the County

TODD COUNTY is in central Minnesota. It is 41 miles long and 24 miles wide. It has a total area of 627,200 acres, or about 980 square miles. The total water area is about 38 square miles.

Farming is the most important enterprise in the county. Corn, hay, and oats are the major crops. They are grown mainly as livestock feed. Most of the industries in the county are related to agriculture, but some recreational and light industrial products also are manufactured.

The soils in the county generally are moderately dark and range from nearly level to very steep. Most formed in loamy glacial till. Sandy and gravelly soils are along streams.

The original vegetation in the county was mainly mixed hardwoods and small areas of tall prairie grasses and of wetland reeds and sedges.

History and Development

Todd County was named after John Blair Smith Todd, who commanded Fort Ripley at the time that the county was established, in 1855 *(11)*. In 1980, the county had a population of 24,991. It has 11 incorporated cities: Bertha, Browerville, Burtrum, Clarissa, Eagle Bend, Gray Eagle, Hewitt, Long Prairie, Osakis, Staples, and West Union. Long Prairie is the county seat. It was first platted in May 1867 and was incorporated in 1883. In 1980, it had a population of 2,859.

The first railroad in the county was built in 1872. It extended across the northern end of the county. Freight service is available in most of the county. A cross-county passenger train has a stop in Staples. There are all-weather airports for small craft in Long Prairie and Staples. The major highways are Interstate Highway 94, U.S. Highways 10 and 71, and State Highways 27 and 210. County and township roads serve the rural areas. Many of the county roads are paved or blacktopped.

Grain elevators are throughout the county. Most of the grain and forage grown in the county is used on local dairy farms. Dairy farming is the largest industry, and milk is the most important agricultural commodity.

Physiography, Relief, and Drainage

The highest elevation in Todd County is about 1,498 feet above sea level. It is on the St. Croix glacial moraine, at Tower Love Hill, which is in the east-central part of the county. The lowest point is about 1,159 feet above sea level. It is in an area in the eastern part of the county where the Swan River flows into Morrison County, directly north of Swanville.

The Wadena drumlin field covers about 40 percent of the county. It is north and west of the Long Prairie River. Drumlins are low, elongated hills that have long, smooth side slopes. Because of the gentle slopes, drainage outlets are not readily available. The major landform in the eastern third of the county is the St. Croix moraine complex, which has short, steep slopes that extend in many directions.

The southwestern part of the county is an upland till plain that is part of the Des Moines Lobe of the late Wisconsin Glaciation. It is characterized by short, uneven slopes that range from nearly level to steep. The soils formed in loamy material.

The Long Prairie River is the major stream in the county. It flows east to Long Prairie and then turns north-northeast and flows to the north end of the county and into Morrison County, at Motley. The Sauk River drains the southwestern part of the county from Lake Osakis to Sauk Lake and into Stearns County. The eastern and southeastern parts of the county are drained by the Swan River, which flows into Morrison County at Swanville. The northwestern part of the county is drained by the Wing River, which flows north into Wadena County.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

In Todd County winters are very cold and summers are short and fairly warm. A short freeze-free period during the summer limits cropping mainly to forage, small grain, and adapted vegetables. Precipitation is fairly well distributed throughout the year, reaching a slight peak in summer. Snow covers the ground much of the time from late fall through early spring.

Soils occasionally freeze to a depth of several feet when very cold weather occurs before the ground is appreciably covered with snow. Usually, the soil is frozen only in the top few inches or to a depth of 1 foot. Where the snow cover has been removed, however, the soil is frozen to a greater depth.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Long Prairie, Minnesota, in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 11 degrees F, and the average daily minimum temperature is 1 degree. The lowest temperature on record, which occurred at Long Prairie on February 1, 1951, is -42 degrees. In summer the average temperature is 68 degrees, and the average daily maximum temperature is 80 degrees. The highest recorded temperature, which occurred at Long Prairie on June 14, 1979, is 100 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 26.73 inches. Of this, about 19 inches, or 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 15 inches. The heaviest 1-day rainfall during the period of record was 8.9 inches at Long Prairie on July 22, 1972. Thunderstorms occur on about 38 days each year.

The average seasonal snowfall is about 46 inches. The greatest snow depth at any one time during the period of record was 41 inches. On the average, 72 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 75 percent. The sun shines 65 percent of the time possible in summer and 40 percent in winter. The prevailing wind is from the west. Average windspeed is highest, 12 miles per hour, in spring.

Farming

Farms in Todd County are decreasing in number and increasing in size. The number decreased from 2,376 in 1970 to 2,300 in 1980. During this period, the average size of the farms increased from 197 to 224 acres.

Corn is the most important crop in the county. Hay is the second most important crop. The trend has been toward a decrease in the acreage used for barley, oats, soybeans, and rye and an increase in the acreage used for corn. In 1982, about 130,000 acres was planted to corn and soybeans, 89,400 acres to hay, and 70,000 acres to small grain. The acreage used for corn varies annually in response to market prices.

Generally, the number of livestock in the county has decreased in recent years. The number of farms raising livestock also has decreased, but the number of livestock per farm has increased. The chief kinds of livestock are dairy cows and beef cattle. In 1980, the county had about 30,000 dairy cows.

Woodland

Approximately 90,000 acres in Todd County is native woodland. Scattered woodlots are throughout the county. The eastern third of the county has the most tracts of uncleared land and the largest ones. The main species are northern red oak, white oak, basswood, maple, aspen, birch, and some white pine. Eastern cottonwood, bur oak, aspen, elm, and red pine are common on the sandy Arvilla, Dorset, Menahga, and Mahtomedi soils. Elm, aspen, and jack pine are common on Meehan and Roscommon soils and willow and tamarack on Rifle and Tacoosh soils.

The early settlers were loggers who came to the survey area to harvest timber and ship the lumber out to other areas. Most of the farmland in the county is in formerly wooded areas from which the trees have been cleared.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in series concepts, different soil patterns, and variations in the design of associations, some soil boundaries and names in this survey do not match those in the published soil surveys of Stearns County and Douglas County.

Soil Descriptions

Soils Formed Dominantly in Calcareous, Loamy Wadena Lobe Glacial Till

These soils are well drained to very poorly drained. They are used dominantly as cropland. Erosion and wetness are the main management concerns.

1. Rockwood-Blowers-Paddock Association

Nearly level to steep, well drained to somewhat poorly drained, loamy soils on drumlins and moraines

This association is on drumlins and moraines separated by low, nearly level areas. The drumlins are elongated hills and are oriented from northeast to southwest. They have long, smooth side slopes in all areas, except for those cut by streams. The low, wet areas between the drumlins are long and narrow. Slopes range from 0 to 25 percent.

This association makes up about 35 percent of the county. It is about 27 percent Rockwood soils, 26 percent Blowers soils, 17 percent Paddock soils, and 30 percent minor soils (fig. 1).

Rockwood soils are on the convex crests and upper sides of drumlins. They are gently sloping to steep and are well drained. Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is dark brown sandy loam about 8 inches thick. The subsoil is dark yellowish brown sandy loam about 30 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, firm, calcareous sandy loam.

Blowers soils are on the lower side slopes and flats on drumlins and ground moraines. They are nearly level and gently sloping and are moderately well drained. Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The subsurface layer is dark grayish brown and yellowish brown sandy loam about 21 inches thick. The subsoil is sandy loam about 13 inches thick. The upper part is yellowish brown and grayish brown and is mottled, and the lower part is yellowish brown. The underlying material to a depth of about 60 inches is yellowish brown, firm, calcareous sandy loam.

Paddock soils are on the lower toe slopes on drumlins and ground moraines. They are nearly level and somewhat poorly drained. Typically, the surface layer is very dark brown sandy loam about 9 inches thick. The subsurface layer is dark grayish brown, mottled sandy loam about 6 inches thick. The subsoil is mottled sandy loam about 28 inches thick. The upper part is grayish brown, and the lower part is dark yellowish brown and dark grayish brown. The underlying material to a depth of about 60 inches is light olive brown, mottled, firm, calcareous sandy loam.

Minor in this association are the poorly drained and very poorly drained Runeberg soils and the very poorly drained Rifle and Tacoosh soils. Runeberg soils are on

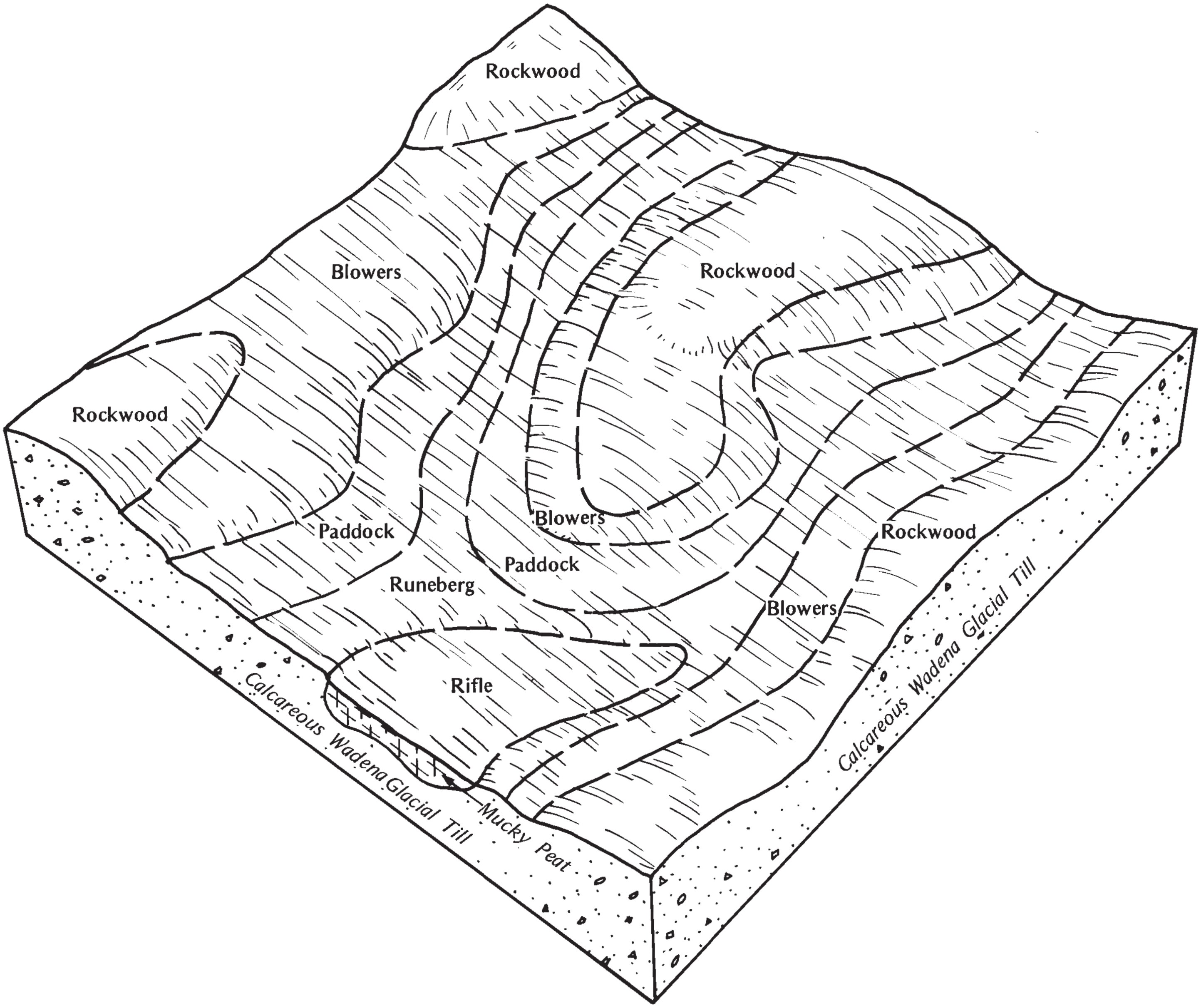

Rockwood
Blowers
Rockwood
Rockwood
Paddock
Blowers
Paddock
Runeberg
Rockwood
Blowers
Rifle
Calcareous Wadena Glacial Till
Mucky Peat
Calcareous Wadena Glacial Till

Figure 1.—Pattern of soils and parent material in the Rockwood-Blowers-Paddock association.

toe slopes on the lower parts of the drumlins. Rifle and Tacoosh soils are in broad drainageways between the drumlins.

About 70 percent of the acreage in this association has been cleared. Most of the low areas are used as pasture. The uncleared acreage consists of woodlots and areas that are too wet for farming.

In some areas the major soils are well suited or fairly well suited to the crops commonly grown in the county, but in other areas they are poorly suited or unsuited. Measures that control water erosion are needed on the long, smooth slopes. A dense layer in the soils limits root penetration and the downward movement of water. A perched water table is above the dense layer during the spring and following heavy rainfall. Because of stoniness, rock picking is a common management need on these soils. A drainage system is needed in some areas.

The major soils are well suited to trees. Both hardwoods and evergreens grow well. The main management concern is plant competition around new seedlings.

2. Kandota-Wykeham-Runeberg Association

Nearly level to steep, well drained, moderately well drained, poorly drained, and very poorly drained, loamy soils on moraines, drumlins, and uplands

This association is on knolls and hills, on nearly level plains, and in depressions, drainageways, and potholes. Slopes range from 0 to 25 percent.

This association makes up about 12 percent of the county. It is about 45 percent Kandota soils, 13 percent Wykeham soils, 15 percent Runeberg soils, and 27 percent minor soils (fig. 2).

Kandota soils are on summits and side slopes on ground moraines and uplands. They are gently sloping to steep and are well drained. Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The subsurface layer is yellowish brown and dark yellowish brown sandy loam about 20 inches thick. The subsoil is about 14 inches of dark yellowish brown and yellowish brown sandy clay loam and sandy loam. The underlying material to a depth of about 60 inches is light yellowish brown and yellowish brown, calcareous sandy loam.

Wykeham soils are in plane or slightly convex areas on moraines. They are nearly level and gently sloping and are moderately well drained. Typically, the surface layer is very dark gray fine sandy loam about 7 inches thick. The subsurface layer is grayish brown gravelly sandy loam about 4 inches thick. The subsoil is about 27 inches thick. The upper part is dark yellowish brown fine sandy loam; the next part is dark yellowish brown and yellowish brown, mottled sandy clay loam; and the lower part is yellowish brown, mottled, calcareous fine sandy loam. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous fine sandy loam.

Runeberg soils are in depressions, drainageways, and potholes on drumlins and ground moraines. They are nearly level and are poorly drained and very poorly drained. Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark gray sandy loam about 3 inches thick. The subsoil is mottled sandy loam about 15 inches thick. The upper part is dark grayish brown, and the lower part is yellowish brown. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous sandy loam.

Minor in this association are the very poorly drained Rifle and Cathro soils and the well drained Dorset soils. The organic Rifle and Cathro soils are in depressions. Dorset soils are on sloping moraines. They have sand and gravel in the lower part.

About 70 percent of this association has been cleared. Most of the cleared areas are used as cropland. The lower areas of poorly drained soils and the steeper areas are used as pasture or woodland.

In some areas the major soils are well suited or fairly well suited to the crops commonly grown in the county, but in other areas they are poorly suited or unsuited. Measures that control water erosion are needed in the steeper areas. A drainage system is needed in low areas.

The major soils are well suited to trees. Hardwoods, such as oak and maple, grow well. Evergreens also grow well. The main management concern is plant competition around new seedlings.

Soils Formed Dominantly in Calcareous, Loamy Des Moines Lobe Glacial Till

These soils are well drained, moderately well drained or poorly drained. They are used dominantly as cropland. Wetness and erosion are the main management concerns.

3. Roliss-Gonvick-Waukon Association

Nearly level to steep, poorly drained, moderately well drained, and well drained, loamy soils on moraines and till plains

This association is on hills that rise 20 to 50 feet above low swales. Many small potholes are throughout the association. Slopes range from 0 to 25 percent.

This association makes up about 5 percent of the county. It is about 40 percent Roliss soils, 30 percent Gonvick soils, 15 percent Waukon soils, and 15 percent minor soils (fig. 3).

Roliss soils are on broad flats and along the rims of depressions on till plains. They are nearly level and poorly drained. Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsurface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 8 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled, calcareous loam.

Gonvick soils are on broad summits, rises, and toe slopes on the hills and at the head of drainageways. They are gently sloping and moderately well drained. Typically, the surface soil is black loam about 12 inches

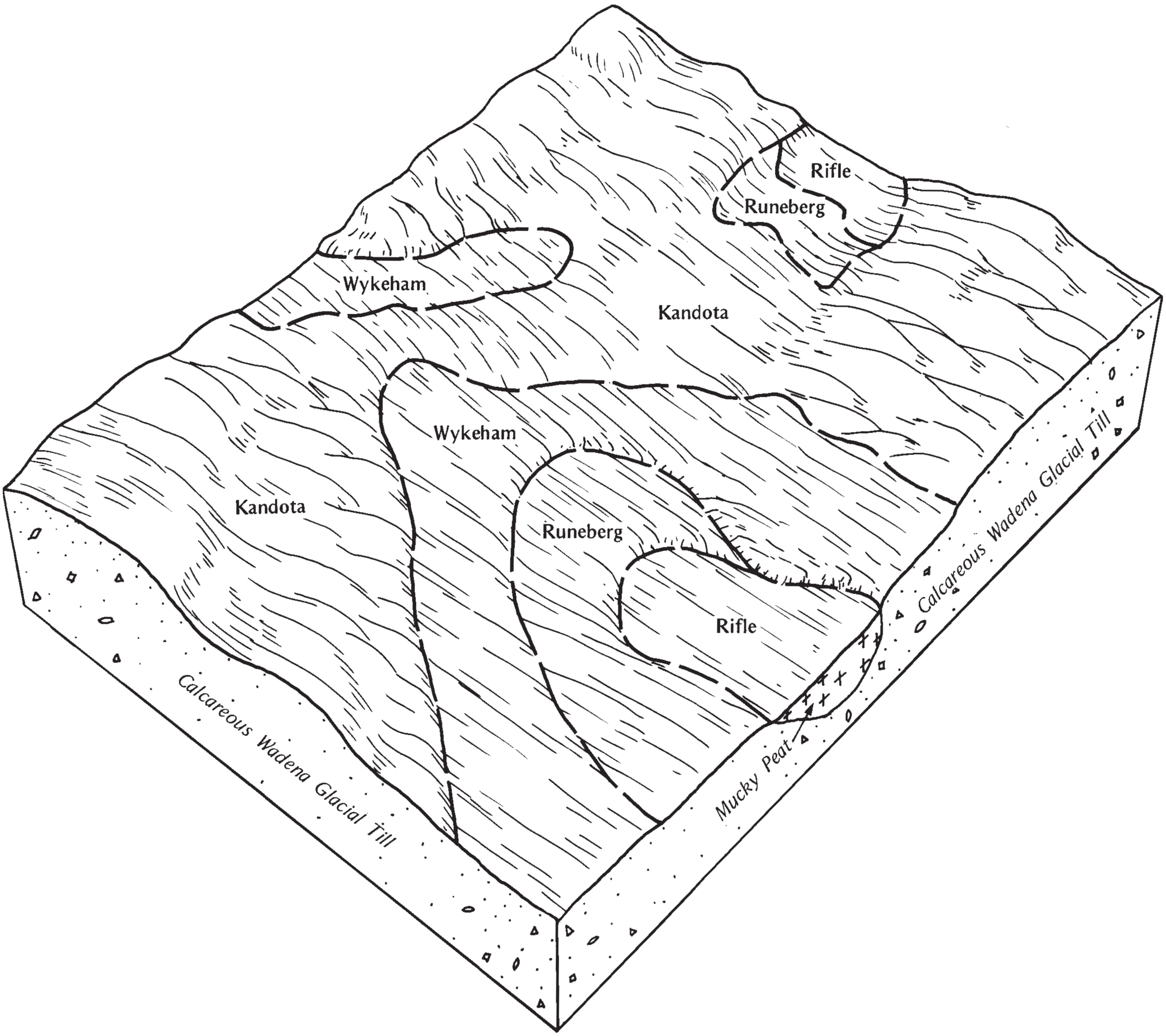

Rifle
Runeberg
Wykeham
Kandota
Wykeham
Kandota
Runeberg
Rifle
Calcareous Wadena Glacial Till
Calcareous Wadena Glacial Till
Mucky Peat

Figure 2.—Pattern of soils and parent material in the Kandota-Wykeham-Runeberg association.

thick. The subsoil is dark brown and dark grayish brown, mottled loam about 20 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam.

Waukon soils are on the summits and side slopes of moraines. They are gently sloping to steep and are well drained. Typically, the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 3 inches thick. The subsoil is dark brown and dark yellowish brown loam about 21 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam.

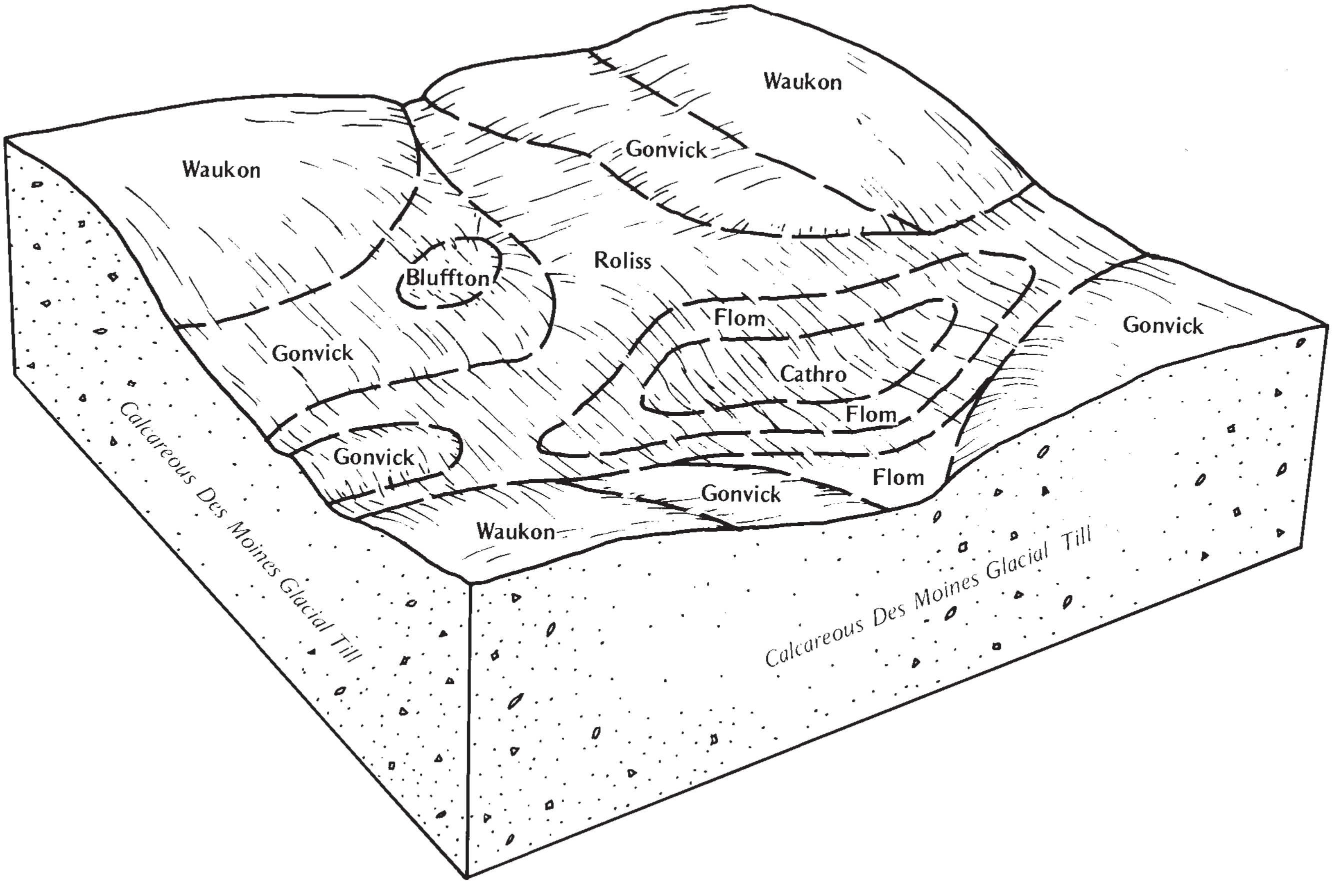


Figure 3.—Pattern of soils and parent material in the Roliss-Gonvick-Waukon association.

Minor in this association are the very poorly drained Bluffton and Cathro and poorly drained Flom soils. Bluffton soils formed in a mantle of loamy material and in the underlying calcareous, loamy glacial till. They are in shallow depressions, swales, and drainageways. Cathro soils formed in organic deposits in depressions. Flom soils formed in loamy glacial till in shallow drainageways and on broad flats.

Most areas of this association are used as cropland. A few are used as wooded pasture or as woodland. In some areas the major soils are well suited or fairly well suited to the crops commonly grown in the county, but in other areas they are poorly suited or unsuited. Controlling water erosion and draining the soils that have a seasonal high water table are the main management concerns.

The major soils are well suited to woodland. Native hardwoods grow well.

4. Ves-Roliss-Normania Association

Nearly level to sloping, well drained, poorly drained, and moderately well drained, loamy soils on ground moraines and till plains

This association is in large, shallow drainageways and on rises and low hills. Many small potholes are throughout the association. Slopes range from 0 to 12 percent.

This association makes up about 4 percent of the county. It is about 40 percent Ves soils, 25 percent Roliss soils, 20 percent Normania soils, and 15 percent minor soils.

Ves soils are on rises, side slopes, and ridges on ground moraines and till plains. They are gently sloping and sloping and are well drained. Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is mixed very dark brown and black loam about 5 inches thick. The subsoil is dark yellowish brown and olive brown loam about 21 inches thick. It is calcareous in the lower part. The underlying material to a depth of about 60 inches is olive brown, calcareous loam.

Roliss soils are on broad flats and along the rims of depressions on till plains. They are nearly level and poorly drained. Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsurface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 8 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled, calcareous loam.

Normania soils are on broad, smooth flats and low rises on ground moraines and till plains. They are nearly level and gently sloping and are moderately well drained. Typically, the surface layer is black loam about 12 inches thick. The subsoil is dark grayish brown and grayish brown loam about 27 inches thick. It typically is mottled and calcareous in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and grayish brown, calcareous loam.

Minor in this association are the very poorly drained Cathro and poorly drained Flom soils in depressions.

Most areas of this association are used as cropland. The major soils are well suited or fairly well suited to most of the crops commonly grown in the county. Controlling water erosion in the sloping areas and draining the soils that have a seasonal high water table are the main management concerns.

Soils Formed Dominantly in Loamy or Sandy Rainy Lobe Glacial Till or in Organic Deposits

These soils are well drained or very poorly drained. They are used dominantly as woodland. Erosion and wetness are the main management concerns.

5. Flak-Rifle Association

Nearly level to sloping, well drained and very poorly drained, loamy and mucky soils on moraines, drumlins, till plains, and outwash plains

This association is on hills and ridges. The hills have long, smooth slopes. Slopes range from 0 to 12 percent.

This association makes up about 1 percent of the county. It is about 45 percent Flak soils, 20 percent Rifle soils, and 35 percent minor soils.

Flak soils are on the summits and side slopes of hills and knolls on drumlins and ground moraines. They are gently sloping and sloping and are well drained. Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is dark brown sandy loam about 6 inches thick. The subsoil also is dark brown sandy loam. It is about 19 inches thick. The underlying material to a depth of about 60 inches is dark brown, firm sandy loam.

Rifle soils are generally in bogs, potholes, and large, saucer-shaped depressions on till plains, outwash plains, and moraines. They are nearly level and very poorly drained. Typically, the surface layer is black muck about 9 inches thick. The underlying material to a depth of about 60 inches is dark brown and brown mucky peat.

Minor in this association are the somewhat poorly drained Nokay soils and the very poorly drained Prebish and Cathro soils. Nokay soils are on the toe slopes of drumlins and the rims of depressions. Prebish and Cathro soils are in the depressions.

About 55 percent of the acreage in this association has been cleared and is used as cropland. In some areas the major soils are well suited or fairly well suited to the crops commonly grown in the county, but in other areas they are poorly suited or unsuited. Measures that control water erosion are needed in the sloping areas.

The major soils can produce high forage yields in pastured areas. Compaction occurs if the pasture is grazed during wet periods.

The major soils are well suited to woodland. Most tree species grow well.

6. Cushing-DeMontreville-Rifle Association

Nearly level to very steep, well drained and very poorly drained, loamy, sandy, or mucky soils on moraines, till plains, and outwash plains

This association is on hills and ridges. It is the steepest association in the county. The hills generally have short, steep slopes. The ridges are long and irregularly shaped and have many short, complex slopes. Slopes range from 0 to 45 percent.

This association makes up about 12 percent of the county. It is about 30 percent Cushing soils, 25 percent DeMontreville soils, 20 percent Rifle soils, and 25 percent minor soils (fig. 4).

Cushing soils are generally on side slopes and summits on ground and end moraines. They are gently sloping to very steep and are well drained. Typically, the surface layer is very dark gray sandy loam about 3 inches thick. The subsurface layer is brown sandy loam about 14 inches thick. The subsoil is about 37 inches of dark brown sandy loam and sandy clay loam. The

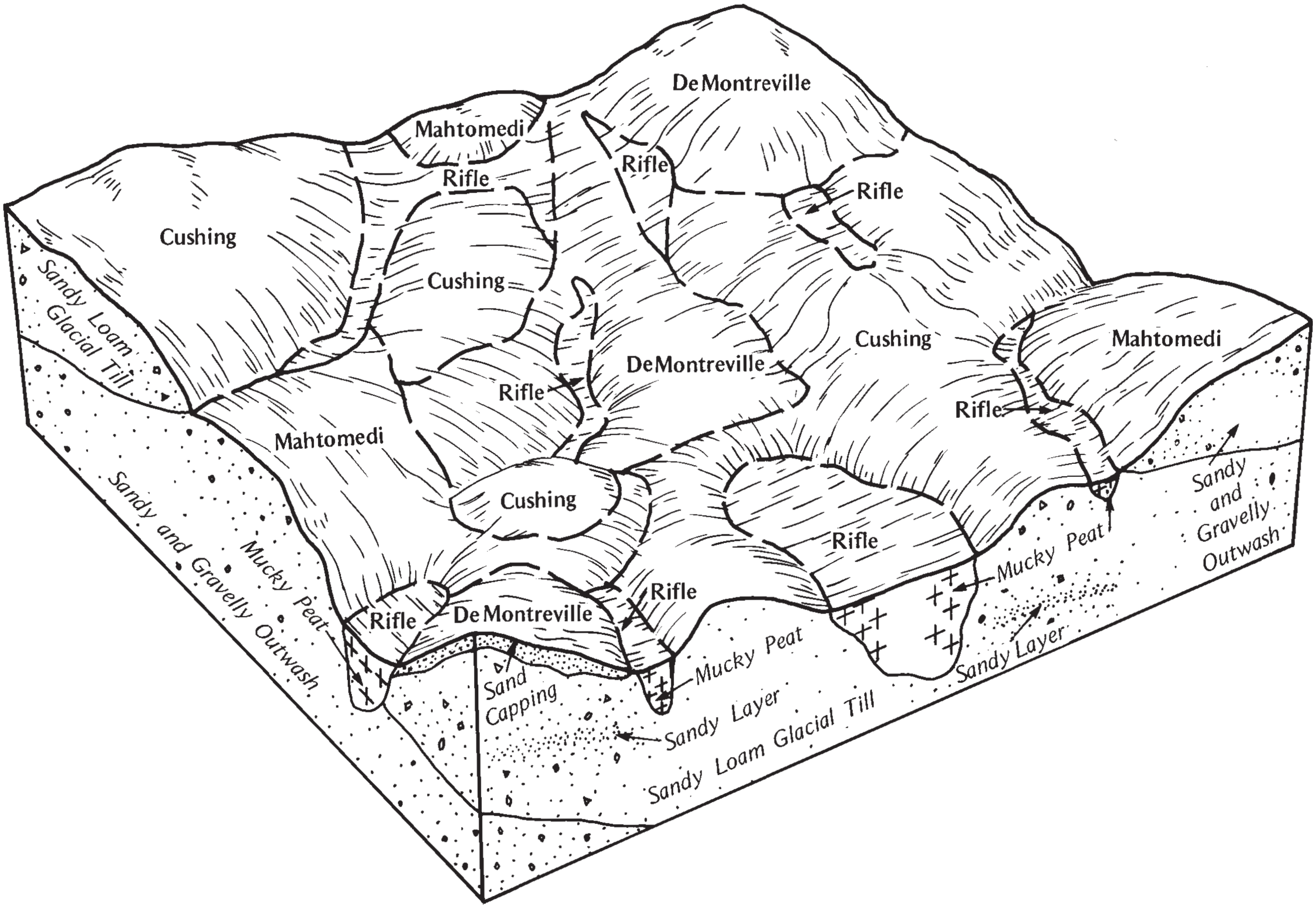

DeMontreville
Mahtomedi
Rifle
Rifle
Rifle
Cushing
Sandy Loam Glacial Till
Cushing
Cushing
DeMontreville
Mahtomedi
Rifle
Rifle
Mahtomedi
Cushing
Sandy and Gravelly Outwash
Mucky Peat
Sandy and Gravelly Outwash
Rifle
Mucky Peat
Rifle
Rifle
DeMontreville
Sandy Layer
Sand Capping
Mucky Peat
Sandy Layer
Sandy Loam Glacial Till

Figure 4.—Pattern of soils and parent material in the Cushing-DeMontreville-Rifle association.

underlying material to a depth of about 60 inches is dark brown sandy loam.

DeMontreville soils are generally on sand-mantled summits and side slopes on ground and end moraines. They are gently sloping to very steep and are well drained. Typically, the surface layer is very dark brown loamy sand about 3 inches thick. The subsurface layer is dark brown loamy sand about 20 inches thick. The subsoil is dark yellowish brown and dark brown sandy loam about 25 inches thick. The underlying material to a depth of about 60 inches is dark brown sandy loam.

Rifle soils are generally in bogs, potholes, and large, saucer-shaped depressions on till plains, outwash plains, and moraines. They are nearly level and very poorly drained. Typically, the surface layer is black muck about 9 inches thick. The underlying material to a depth of about 60 inches is dark brown and brown mucky peat.

Minor in this association are the moderately well drained Alstad and Prebish soils, the somewhat poorly drained Nokay soils, and the excessively drained Mahtomedi soils. Prebish and Nokay soils are in depressions. Alstad soils are on toe slopes and the upper parts of drainageways. Mahtomedi soils are on convex side slopes and nose slopes.

About 25 percent of the acreage in this association has been cleared and is used as cropland. Most of the cropland is in the more nearly level areas. In some areas the major soils are well suited or fairly well suited to the crops commonly grown in the county, but in other

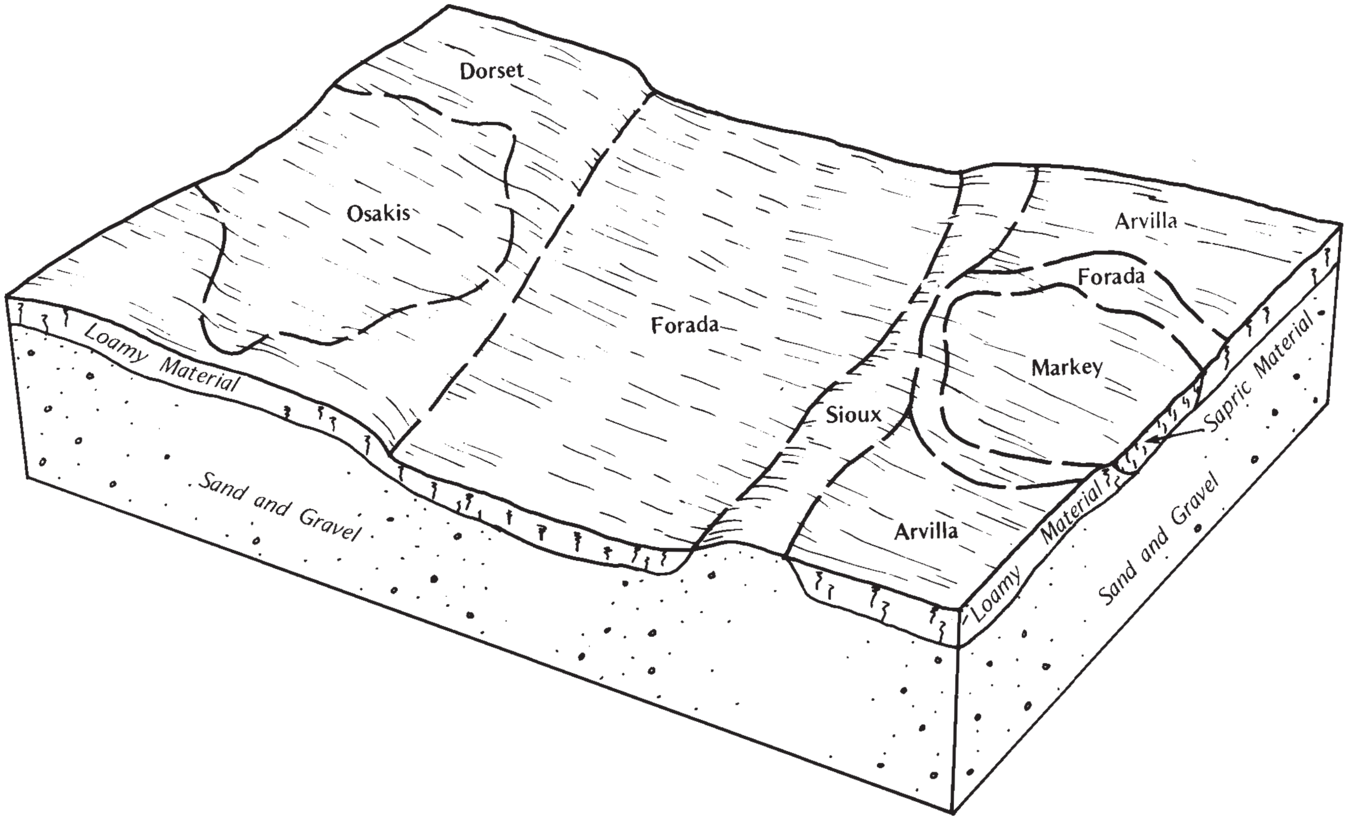


Figure 5.—Pattern of soils and parent material in the Forada-Dorset-Arvilla association.

areas they are poorly suited or unsuited. The slope and droughtiness are the main management concerns.

The steeper areas are used as woodland or pasture. Because of the hazard of erosion, the pastured areas should not be overgrazed. The major soils are well suited to woodland. Most tree species grow well. Hardwoods, such as oak, maple, and elm, are the dominant trees. The use of equipment is limited in the steeper areas, and care is needed in operating harvesting equipment.

Soils Formed Dominantly in Loamy Outwash Over Sand and Gravel

These soils are somewhat excessively drained, well drained, or poorly drained. They are used dominantly as cropland. The main management concerns are erosion, wetness in some areas, and droughtiness in other areas.

7. Forada-Dorset-Arvilla Association

Nearly level to sloping, poorly drained, well drained, and somewhat excessively drained, loamy soils on outwash plains and moraines

The landscape of this association is one of flats, low rises, and a few depressions. Slopes range from 0 to 12 percent.

This association makes up about 12 percent of the county. It is about 25 percent Forada soils, 25 percent Dorset soils, 20 percent Arvilla soils, and 30 percent minor soils (fig. 5).

Forada soils are in swales, on broad flats, and on the rims of depressions on outwash plains. They are nearly level and poorly drained. Typically, the surface layer is black sandy loam about 12 inches thick. The subsurface layer is very dark gray sandy loam about 6 inches thick. The subsoil is about 15 inches thick. It is dark grayish brown and grayish brown, mottled sandy loam in the upper part and dark grayish brown loamy sand in the lower part. The underlying material to a depth of about 60 inches is dark grayish brown and light brownish gray, mottled, calcareous coarse sand.

Dorset soils are in plane or convex areas on outwash plains and moraines. They are gently sloping and sloping and are well drained. Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam, and the lower part is yellowish brown gravelly sand. The underlying material to a depth of about 60 inches is pale brown, calcareous gravelly coarse sand.

Arvilla soils are on broad outwash plains. They are nearly level to sloping and are somewhat excessively drained. Typically, the surface layer is black sandy loam about 11 inches thick. The subsurface layer is very dark gray and dark brown sandy loam about 5 inches thick. The subsoil is about 14 inches thick. The upper part is dark brown sandy loam and loamy sand, and the lower part is dark brown gravelly sand. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand.

Minor in this association are the very poorly drained Markey soils, the moderately well drained Osakis soils, and the excessively drained Sioux soils. Markey soils are in depressions. Osakis soils are on broad flats and low rises. Sioux soils are on the steeper slopes.

About 70 percent of this association has been cleared and is used as cropland. The main limitation is droughtiness. Irrigation improves productivity. Measures that control water erosion are needed in the sloping areas. Controlling runoff and conserving rainwater reduce the hazards of drought and erosion.

The major soils are suited to pasture, but forage yields are reduced during the hot summer months, when the pasture tends to dry out. Warm-season grasses grow well.

The major soils are well suited to woodland, but seedling mortality is high during dry years.

Soils Formed Dominantly in Sandy Outwash or Organic Deposits

These soils are excessively drained, somewhat poorly drained, poorly drained, or very poorly drained. They are used dominantly as woodland, cropland, or wildlife habitat. Wetness and erosion are the main management concerns.

8. Menahga-Hubbard-Bowstring Association

Nearly level to steep, excessively drained and very poorly drained, sandy or mucky soils on outwash plains and valley trains

This association is on flats and low, rolling rises that have a few depressions. Slopes range from 0 to 25 percent.

This association makes up about 16 percent of the county. It is about 30 percent Menahga soils, 25 percent Hubbard soils, 20 percent Bowstring soils, and 25 percent minor soils (fig. 6).

Menahga soils are on broad outwash plains and valley trains. They are gently sloping to steep and are excessively drained. Typically, the surface layer is very dark grayish brown loamy sand about 3 inches thick. The subsoil is yellowish brown and dark yellowish brown sand about 26 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown sand.

Hubbard soils are on broad outwash plains and valley trains. They are nearly level and gently sloping and are excessively drained. Typically, the surface layer is black loamy sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy sand about 7 inches thick. The subsoil is dark brown sand about 15 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand.

Bowstring soils are on flood plains along the major rivers. They are nearly level and are very poorly drained. Typically, the surface layer is black muck about 10 inches thick. The subsoil is about 26 inches of stratified black muck and gray, mottled sand. The underlying material to a depth of about 60 inches is grayish brown sand that has layers of black muck.

Minor in this association are the somewhat poorly drained and moderately well drained Duelm soils, the somewhat poorly drained Meehan soils, the very poorly drained Rifle soils, and the very poorly drained and poorly drained Roscommon soils. Duelm soils are on slight rises. Meehan soils are in slight depressions. Rifle soils are in bogs, potholes, and large depressions. Roscommon soils are in depressions and old drainageways.

About 65 percent of this association has been cleared and is used as cropland. The rest is used as woodland or unimproved pasture. The major soils are poorly suited or unsuited to most of the crops commonly grown in the county. They are better suited to shallow-rooted, early maturing crops than to other crops. The main management concerns are droughtiness in some areas and wetness in others. The soils are suitable for irrigation if an adequate water supply is available.

The major soils are well suited to woodland.

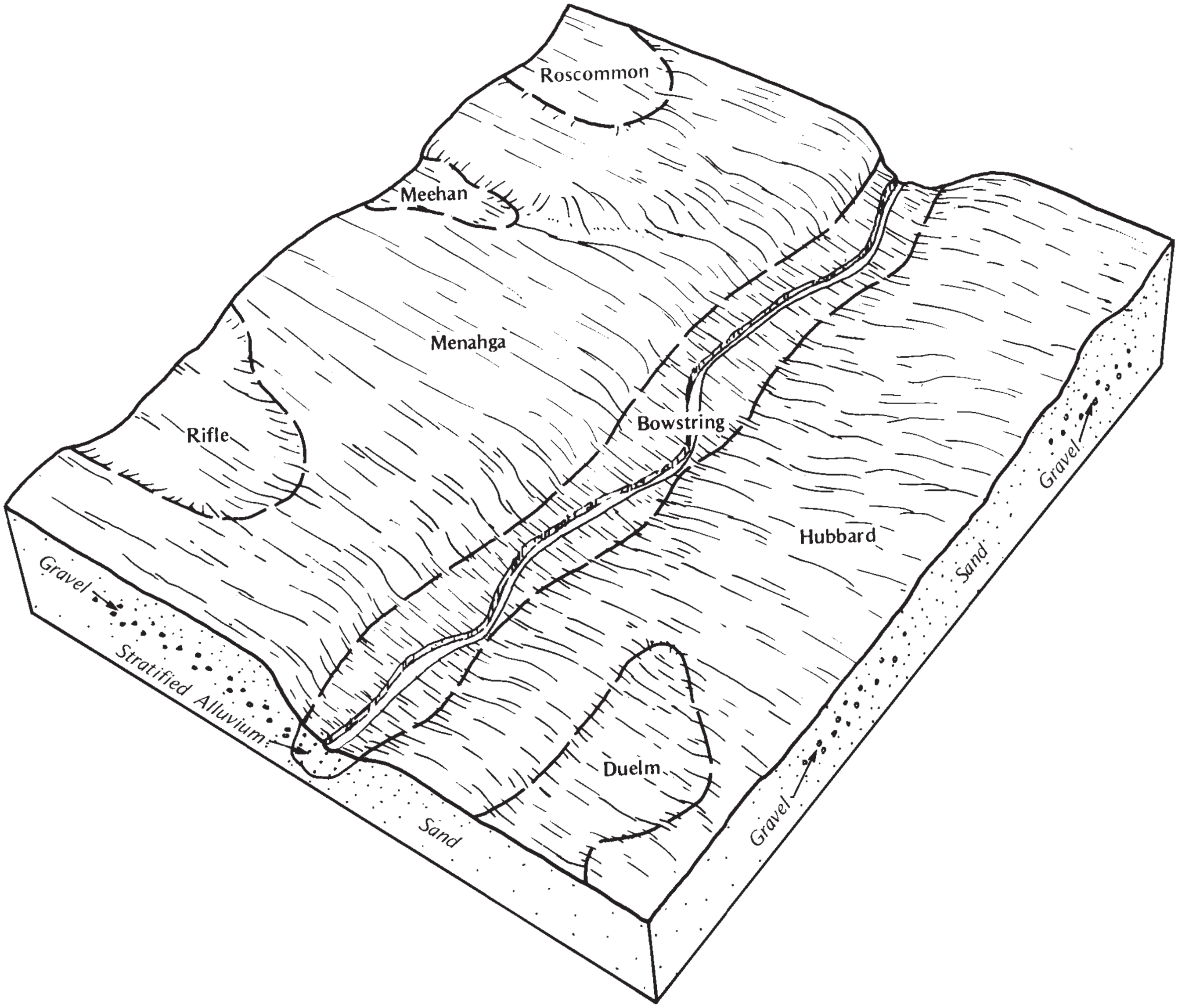


Figure 6.—Pattern of soils and parent material in the Menahga-Hubbard-Bowstring association.

Droughtiness can damage young seedlings.

9. Roscommon-Meehan-Markey Association

Nearly level, somewhat poorly drained to very poorly drained, sandy and mucky soils on outwash plains, stream terraces, and till plains

This association is in nearly level areas that have very wet depressions. Slopes range from 0 to 2 percent.

This association makes up about 3 percent of the county. It is about 30 percent Roscommon soils, 25 percent Meehan soils, 20 percent Markey soils, and 25 percent minor soils.

Roscommon soils are on broad outwash plains. They are poorly drained and very poorly drained. Typically, the surface layer is very dark brown loamy sand about 9 inches thick. The subsoil is grayish brown and light brownish gray, mottled sand about 27 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled sand.

Meehan soils are on outwash plains and stream terraces. They are somewhat poorly drained. Typically, the surface layer is very dark grayish brown loamy sand about 8 inches. The subsoil is about 27 inches thick. The upper part is dark yellowish brown sand, and the lower part is brown, mottled coarse sand. The underlying material to a depth of about 60 inches is dark yellowish brown and pale brown, mottled sand.

Markey soils are in depressions on outwash plains and till plains. They are very poorly drained. Typically, the upper 38 inches is black, very dark brown, and very dark gray muck. The underlying material to a depth of about 60 inches is dark gray, mottled sand.

Minor in this association are the excessively drained Menahga soils and the very poorly drained Rifle soils. Menahga soils are on rises and hills. Rifle soils formed in more than 51 inches of organic material in bogs, potholes, and depressions.

Most areas of this association are used as pasture or hayland. The major soils are suited to pasture. Deferment of grazing when the soil is wet minimizes compaction, improves tilth, and increases forage production.

The major soils are well suited, fairly well suited, or poorly suited to trees. The best suited species are those that can withstand seasonal wetness.

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Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. The management practices are intended to increase crop production, conserve the soil resource, and protect the quality of the environment. Over a period of time, these practices may or may not be in accordance with federal, state, and local laws. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Dorset sandy loam, 2 to 6 percent slopes, is a phase of the Dorset series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Waukon-Langhei loams, 4 to 12 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Aquolls and Histosols, ponded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

As a result of changes in series concepts, different soil patterns, and variations in the design of map units, some soil boundaries and names in this survey do not match those in the published soil surveys of Douglas County and Stearns County.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

7A—Hubbard loamy sand, 0 to 2 percent slopes. This nearly level, excessively drained soil is on broad flats on outwash plains and valley trains. Areas are irregular in shape and range from 5 to about 200 acres in size.

Typically, the surface layer is black loamy sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy sand about 9 inches thick. The subsoil is dark brown sand about 25 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand. In some areas the surface soil is more than 22 or less than 10 inches thick. In other areas the depth to lime is less than 50 inches. In some places the subsoil contains more gravel. In other places the surface layer is coarse sandy loam. In some small areas the slope is more than 2 percent.

Included with this soil in mapping are small areas of Arvilla, Duelm, and Isan soils, which make up 5 to 8 percent of the unit. The somewhat excessively drained Arvilla soils contain more clay in the surface soil and subsoil than the Hubbard soil. The somewhat poorly drained and moderately well drained Duelm soils are in plane or slightly concave areas at the lower elevations. The poorly drained and very poorly drained Isan soils are in shallow depressions and drainageways.

Air and water move through the Hubbard soil at a rapid rate. The available water capacity and natural fertility are low. Surface runoff is slow in cultivated areas. The content of organic matter is moderate.

Most areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. If irrigated, it is well suited to potatoes and other crops (fig. 7). Droughtiness retards crop growth in most years. The main management needs are measures that conserve moisture and improve fertility. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure and returning crop residue to the soil improve fertility. If a good source of water is available, irrigation can minimize the droughtiness. The response of crops to irrigation is good. Center-pivot and traveling-gun systems are the most common methods of irrigation. Low-pressure systems work well and are energy efficient.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing results in water erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a high rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVs. The woodland ordination symbol is 2S.

7B—Hubbard loamy sand, 2 to 6 percent slopes. This gently sloping and gently undulating, excessively drained soil is on summits and side slopes on outwash plains and valley trains. Areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is black loamy sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy sand about 7 inches thick. The subsoil is dark brown sand about 15 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand. In some areas the surface soil is more than 22 or less than 10 inches thick. In other areas the depth to lime is less than 50 inches. In some places the subsoil contains more gravel. In other places the surface soil and subsoil contain more clay. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Duelm and Isan soils, which make up 5 to 10 percent of the unit. The somewhat poorly drained and moderately well drained Duelm soils are in plane or slightly concave areas at the lower elevations. The poorly drained and very poorly drained Isan soils are in shallow depressions and drainageways.

Air and water move through the Hubbard soil at a rapid rate. The available water capacity and natural fertility are low. Surface runoff is slow in cultivated

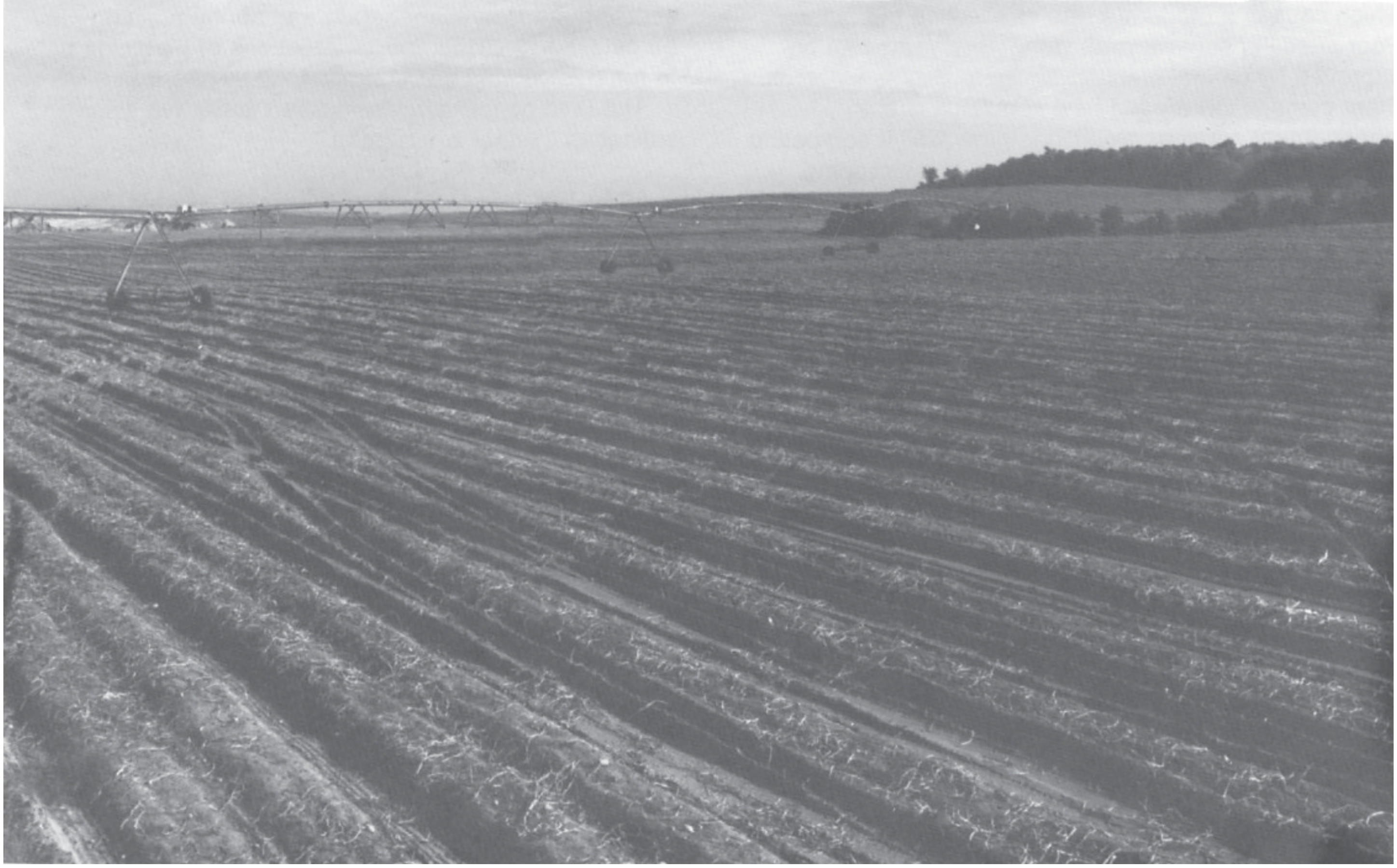

Figure 7.—An irrigated area of Hubbard loamy sand, 0 to 2 percent slopes. Potatoes were harvested in the area.

areas. The content of organic matter is moderate.

Most areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. If irrigated, it is well suited to potatoes and other crops. Droughtiness retards crop growth in most years. The main management needs are measures that conserve moisture and improve fertility. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure and returning crop residue to the soil improve fertility. If a good source of water is available, irrigation can minimize the droughtiness. The response of crops to irrigation is good. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include smooth bromegrass, big bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in water erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVs. The woodland ordination symbol is 2S.

36—Flom loam. This nearly level, poorly drained soil is in shallow drainageways and on broad flats on ground and end moraines. It is subject to rare ponding. Areas are irregular in shape and range from 3 to 80 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is grayish brown, mottled loam about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled, calcareous loam. In some areas the soil has an accumulation of lime below a depth of 16 inches. In other areas it has lime in the surface soil.

Included with this soil in mapping are small areas of the moderately well drained Gonvick and Normania soils, which make up 10 to 20 percent of the unit. These soils are at the higher elevations.

Air and water move through the Flom soil at a moderately slow rate. The available water capacity is high. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 1 to 3 feet. Natural fertility and organic matter content are high. The potential for frost action also is high.

Most areas are used as cropland. If drained, this soil is well suited to most of the crops commonly grown in the county. The main management needs are measures that reduce the wetness and improve fertility. Open ditches and subsurface drainage lines can remove excess water if suitable outlets are available. Conservation tillage, winter cover crops, and applications of fertilizer and manure improve fertility.

If drained, this soil is well suited to red clover, birdsfoot trefoil, Garrison creeping foxtail, smooth bromegrass, reed canarygrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet results in surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw. No woodland ordination symbol is assigned.

38B—Waukon loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on broad, convex side slopes, summits, and shoulder slopes on moraines. Areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 3 inches thick. The subsoil is dark brown and dark yellowish brown loam about 21 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some places the surface layer is thicker and darker or is thinner and lighter colored. In other places the slope is less than 2 or more than 6 percent. In areas of Villard Township, the soil formed in silty material.

Included with this soil in mapping are small areas of Flom and Gonvick soils, which make up 5 to 20 percent of the unit. The poorly drained Flom soils are in drainageways and swales. The moderately well drained Gonvick soils are at the lower elevations. Their dark surface layer is thicker than that of the Waukon soil.

Air and water move through the Waukon soil at a moderate rate. The available water capacity is high. Surface runoff and natural fertility are medium. The content of organic matter is moderate or high. The shrink-swell potential and the potential for frost action are moderate.

Most areas are used as cropland. A few are wooded. This soil is well suited to most of the crops commonly grown in the county. Controlling water erosion and maintaining fertility are the main management concerns. Applying a system of conservation tillage, returning crop residue to the soil, and including grasses and legumes in the cropping sequence are effective in controlling water erosion. In places grassed waterways are needed to prevent gullying.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 4A.

38C—Waukon loam, 6 to 12 percent slopes. This sloping, well drained soil is on summits, shoulder slopes, and side slopes on moraines. Areas are irregular in shape and range from 3 to 30 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 3 inches thick. The subsoil is dark brown and dark yellowish brown loam about 18 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some places the surface layer is darker and thicker or is thinner and lighter colored. In other places the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of Flom and Gonvick soils, which make up 5 to 15 percent of the unit. The poorly drained Flom soils are in drainageways, swales, and depressions. The moderately well drained Gonvick soils are at the lower elevations. Their dark surface layer is thicker than that of the Waukon soil. Also included are small areas of organic soils.

Air and water move through the Waukon soil at a moderate rate. The available water capacity is high. Surface runoff is rapid in cultivated areas. The content of organic matter is moderate or high. Natural fertility is medium. The shrink-swell potential and the potential for frost action are moderate.

Most areas are used as cropland. A few are wooded. This soil is fairly well suited to most of the crops commonly grown in the county. Controlling water erosion, maintaining fertility, and conserving moisture are the main management concerns. Applying a system of conservation tillage, returning crop residue to the soil, and including grasses and legumes in the cropping sequence conserve moisture and reduce soil loss. In places grassed waterways are needed to control gully erosion.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

53B—Kandota sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on summits, side slopes, and head slopes on ground moraines. Areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The next layer is yellowish brown and dark yellowish brown sandy loam about 20 inches thick. The subsoil is about 14 inches of dark yellowish brown and yellowish brown sandy clay loam and sandy loam. The underlying material to a depth of about 60 inches is light yellowish brown and yellowish brown, calcareous sandy loam. In some areas the subsoil has less clay. In other areas the surface layer is thicker. In places the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Wykeham and Runeberg soils, which make up 5 to 15 percent of the unit. The moderately well drained Wykeham soils are in the less sloping, slightly concave areas and at the head of drainageways. The poorly drained Runeberg soils are in drainageways and depressional areas.

Air and water move through the Kandota soil at a moderately slow rate. The available water capacity is moderate. Surface runoff is medium in cultivated areas. The content of organic matter is moderate, and natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. Water erosion and soil blowing are the major hazards. A system of conservation tillage, contour farming, stripcropping, crop residue management, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. In some areas grassed waterways are needed to prevent gullying. Applying manure improves fertility, minimizes crusting, and increases the rate of water infiltration. In some areas surface stones interfere with cultivation. Rock picking may be required to remove the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer and lime, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 4A.

53C—Kandota sandy loam, 6 to 12 percent slopes. This sloping, well drained soil is in convex areas on side slopes, head slopes, and nose slopes on ground moraines. Areas are irregular in shape and range from 4 to 150 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 8 inches thick. The next layer is dark grayish brown and dark yellowish brown sandy loam about 14 inches thick. The subsoil is dark yellowish brown and yellowish brown sandy clay loam about 20 inches thick. The underlying material to a depth of about 60 inches is olive brown, calcareous sandy loam. In some places the subsoil has less clay. In other places the dark surface layer is thicker. In some of the steeper areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is dark brown or dark yellowish brown sandy loam or sandy clay loam. In some small areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of Runeberg and Wykeham soils, which make up 2 to 10 percent of the unit. The poorly drained Runeberg soils are in small drainageways. The moderately well drained Wykeham soils are on slightly concave head slopes and in sloping drainageways.

Air and water move through the Kandota soil at a moderately slow rate. The available water capacity is moderate. Surface runoff is medium or rapid in cultivated areas. The content of organic matter is moderate, and natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. Water erosion and soil blowing are the major hazards. Terraces and diversions help to control runoff and water erosion. Farming on the contour, stripcropping, and maintaining a protective vegetative cover help to control water erosion, soil blowing, and runoff. Returning crop residue to the soil and applying manure improve fertility, minimize crusting, and increase the rate of water infiltration and the available water capacity. In some areas surface stones interfere with cultivation. Rock picking may be needed to clear the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

53D—Kandota sandy loam, 12 to 25 percent slopes. This moderately steep and steep, well drained soil is in convex areas on side slopes and nose slopes on ground moraines. Areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsurface layer is dark grayish brown sandy loam about 9 inches thick. The subsoil is dark brown and dark yellowish brown sandy clay loam about 22 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous sandy loam. In places the subsoil is thicker and has less clay. In some of the steeper areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is dark brown or dark yellowish brown sandy loam or sandy clay loam. In some small areas the slope is less than 12 or more than 25 percent.

Included with this soil in mapping are small areas of Dorset soils, which make up 2 to 10 percent of the unit. These soils are in landscape positions similar to those of the Kandota soil. They have gravelly sand at a depth of 2 to 3 feet.

Air and water move through the Kandota soil at a moderately slow rate. The available water capacity is moderate. Surface runoff is rapid in cultivated areas. The content of organic matter is moderate, and natural fertility is medium. The potential for frost action is moderate.

Most areas are used as woodland or as pastured woodland. Some areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. Water erosion is the major hazard. Terraces and diversions, contour farming, stripcropping, and a protective vegetative cover help to control erosion and runoff. Returning crop residue to the soil and applying manure improve fertility, minimize crusting, and increase the rate of water infiltration. In some areas surface stones interfere with cultivation. Rock picking may be needed to clear the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. The normal effectiveness of windbreaks is impaired by the slope. The hazard of erosion is severe unless a plant cover protects the site. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the slope. Erosion on logging roads and skid trails is a major management concern. Building the roads and trails on the contour helps to control erosion. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVe. The woodland ordination symbol is 4R.

75—Bluffton loam. This nearly level, very poorly drained soil is in shallow depressions, swales, and sluggish drainageways on ground moraines. It is subject to ponding. Areas are irregular in shape and range from 4 to 30 acres in size.

Typically, the surface soil is black loam about 20 inches thick. The subsoil is gray, mottled clay loam about 24 inches thick. The underlying material to a depth of about 60 inches is gray, mottled, calcareous sandy loam. Some areas have as much as 16 inches of muck on the surface. In places layers that have more sand are in the subsoil and underlying material.

Included with this soil in mapping are small areas of Cathro, Flom, and Gonvick soils, which make up 5 to 10 percent of the unit. The very poorly drained Cathro soils formed in organic material 16 to 51 inches deep over sandy loam. The poorly drained Flom soils are on slight rises. The moderately well drained Gonvick soils are on toe slopes above the depressions.

Air and water move through the Bluffton soil at a moderately slow rate. Surface runoff is very slow or ponded in cultivated areas. The seasonal high water table is 2 feet above to 2 feet below the surface. The available water capacity, the content of organic matter, and natural fertility are high. The potential for frost action also is high.

This soil is used for pasture or supports native vegetation. It is fairly well suited to the short-season crops commonly grown in the county. The major hazards are ponding and frost action, and the major limitation is wetness. The wetness can be overcome by a drainage system, but establishing drainage outlets is difficult on this nearly level terrain. Ponding can be controlled by diversions and a surface drainage system. Because of the low landscape position, the soil is subject to frost in late spring and early fall.

This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. The best suited species are those that can withstand wet conditions. The major concerns in managing the pastured areas are overgrazing and grazing when the soil is wet. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to the development of wetland wildlife habitat. It is suitable for the construction of impoundments, which can flood the soil. Shallow ponds can be dug for migratory waterfowl and elongated channels for furbearers.

The land capability classification is IIIw. No woodland ordination symbol is assigned.

82B—Redeye loamy sand, 2 to 6 percent slopes. This gently sloping, well drained soil is on plane or convex summits, shoulder slopes, and back slopes on drumlins and till plains. Areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 3 inches thick. The subsurface layer is brown loamy sand about 19 inches thick. The subsoil is dark yellowish brown and yellowish brown sandy loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous, dense till that crushes to sandy loam. In places the sandy surface soil is less than 20 or more than 40 inches thick.

Included with this soil in mapping are small areas of Blowers, Huntersville, Runeberg, and Staples soils, which make up 10 to 15 percent of the unit. The moderately well drained Blowers and Huntersville soils are on foot slopes and toe slopes. The poorly drained Staples and very poorly drained, depressional Runeburg soils are in swales and drainageways.

Air and water move rapidly through the upper part of the Redeye soil and very slowly through the underlying material. Surface runoff is slow in cultivated areas. The available water capacity is moderate. The content of organic matter is moderately low, and natural fertility is low. The potential for frost action is moderate.

Most areas are used as cropland. A few are wooded. This soil is fairly well suited to most of the crops commonly grown in the county. Measures that reduce droughtiness, control erosion, and improve fertility are the main management needs. Applying a system of conservation tillage, returning crop residue to the soil, and including grasses and legumes in the cropping sequence are effective in conserving moisture and controlling erosion. Adding lime improves crop production.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, little bluestem, and indiangrass. Drought is a hazard. Erosion in the steeper areas and soil blowing in all areas are other hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, deferment of grazing during dry periods, applications of lime and fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness. Because of a restricted root zone, the seedling mortality rate is moderate. It can be reduced by careful planting of suitable, vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIs. The woodland ordination symbol is 2S.

82C—Redeye loamy sand, 6 to 12 percent slopes. This sloping, well drained soil is on convex summits, shoulder slopes, and side slopes on drumlins and till plains. Areas are irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 10 inches thick. The subsurface layer is about 14 inches thick. It is dark brown loamy sand in the upper part and dark yellowish brown sand in the lower part. The subsoil is yellowish brown sandy loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous, dense till that crushes to sandy loam. In places the sandy surface soil is less than 20 or more than 40 inches thick.

Included with this soil in mapping are small areas of Blowers, Duelm, Huntersville, and Staples soils, which make up 5 to 15 percent of the unit. The moderately well drained Blowers, Duelm, and Huntersville soils are in shallow swales and drainageways. The poorly drained Staples soils are in shallow depressions and drainageways.

Air and water move rapidly through the upper part of the Redeye soil and very slowly through the underlying material. The available water capacity is moderate. Surface runoff is slow in cultivated areas. The content of organic matter is moderately low, and natural fertility is low. The potential for frost action is moderate.

Most areas are used as cropland. A few are wooded. This soil is fairly well suited to most of the crops commonly grown in the county. Measures that control erosion, reduce droughtiness, and improve fertility are the main management needs. Applying a system of conservation tillage, returning crop residue to the soil, and including grasses and legumes in the cropping sequence conserve moisture and help to control erosion. Applications of fertilizer and lime improve crop production.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, little bluestem, indiangrass, smooth bromegrass, and orchardgrass. Erosion is the main hazard. Overgrazing results in erosion and deterioration of the pasture. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, rotation grazing, weed control, timely deferment of grazing, and applications of lime and fertilizer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness. Because of a restricted root zone, the seedling mortality rate is high. It can be reduced by careful planting of suitable, vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIe. The woodland ordination symbol is 2S.

111—Hangaard sandy loam. This nearly level, poorly drained soil is in swales and on broad flats on outwash plains and stream terraces. Areas are irregular in shape and range from 5 to 120 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The next layer is very dark grayish brown and black, mottled sandy loam about 4 inches thick. The subsoil is dark grayish brown, mottled loamy sand about 4 inches thick. The upper part of the underlying material is strong brown, mottled gravelly loamy coarse sand. The lower part to a depth of about 60 inches is light brownish gray and light yellowish brown, mottled, calcareous sand. In some areas the depth to sand or gravelly sand is more than 20 inches. In other areas the surface layer is loam or muck.

Included with this soil in mapping are small areas of Markey and Osakis soils, which make up 2 to 10 percent of the unit. The very poorly drained Markey soils are in depressions. They formed in organic material over sandy outwash. The moderately well drained Osakis soils are on rises at the slightly higher elevations.

Air and water move through the Hangaard soil at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is medium or high, and organic matter content is moderate or high. The potential for frost action is moderate.

Most areas are used as pasture or hayland. This soil is poorly suited to most of the crops commonly grown in the county. The main management needs are measures that reduce the wetness and improve fertility and tilth. Open ditches or a combination of open drains and tile drainage generally can reduce the wetness, but some areas lack suitable outlets for drainage systems. If cultivated crops are grown, soil blowing is a hazard. Conservation tillage and winter cover crops help to prevent excessive soil loss. Applying fertilizer and manure and returning crop residue to the soil improve fertility and tilth. Crops respond well to irrigation during periods of moisture stress.

This soil is fairly well suited to grasses and legumes for hay or pasture. The wetness is the major limitation. The best suited species are those that can withstand the wet conditions. These include birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail. Overgrazing or grazing when the soil is wet causes surface compaction and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to wetland wildlife habitat. The habitat can be improved by introducing desirable plant species and by excavating shallow water areas.

The land capability classification is IVw. No woodland ordination symbol is assigned.

121—Wykeham fine sandy loam. This nearly level and gently sloping, moderately well drained soil is in plane or slightly convex areas on ground and end moraines. Areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 7 inches thick. The next 12 inches is grayish brown gravelly sandy loam and dark yellowish brown fine sandy loam. The subsoil is about 19 inches thick. The upper part is dark yellowish brown and yellowish brown, mottled sandy clay loam, and the lower part is yellowish brown, mottled, calcareous fine sandy loam. The underlying material to a depth of about 60 inches also is yellowish brown, mottled, calcareous fine sandy loam. In some places the subsoil is thicker. In other places the soil is deeper to calcareous, loamy till. In some areas the dark surface layer is thicker. In other areas the slope is more than 3 percent.

Included with this soil in mapping are small areas of Clotho, Kandota, and Runeberg soils, which make up 5 to 10 percent of the unit. The poorly drained Clotho and Runeberg soils are in shallow depressions and drainageways. Clotho soils are calcareous throughout. The well drained Kandota soils are in the more sloping areas. Also included are areas where the soil has pockets of sand and gravel.

Air and water move through the Wykeham soil at a moderately slow rate. The available water capacity is high. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 2.5 to 5.0 feet. Organic matter content is moderate, and natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. Returning crop residue to the soil or applying manure improves fertility, minimizes crusting, and increases the rate of water infiltration and the available water capacity.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is I. The woodland ordination symbol is 4A.

127A—Sverdrup sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad flats on outwash plains and moraines. Areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black sandy loam about 12 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is about 21 inches thick. It is dark yellowish brown. The upper part is sandy loam, and the lower part is sand. The underlying material to a depth of about 60 inches is light yellowish brown, calcareous sand. In some areas the surface soil is more than 17 inches thick. In other areas the soil has more gravel in the lower part of the subsoil and in the underlying material. In some small areas the slope is more than 2 percent.

Included with this soil in mapping are Duelm, Forada, and Hubbard soils, which make up 5 to 10 percent of the unit. The somewhat poorly drained and moderately well drained Duelm soils are in the lower areas. The poorly drained Forada soils are in drainageways and depressions. The excessively drained Hubbard soils are on rises.

Air and water move through the Sverdrup soil at a moderately rapid rate. Surface runoff is slow in cultivated areas. The available water capacity and natural fertility are low. Organic matter content is moderate.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. The main management needs are measures that conserve moisture, improve fertility, and reduce the susceptibility to soil blowing. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure or returning crop residue to the soil improves fertility. If a good source of water is available, irrigation can minimize the droughtiness. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, smooth bromegrass, little bluestem, and indiangrass. Droughtiness is the major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer and lime, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIs. No woodland ordination symbol is assigned.

127B—Sverdrup sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex side slopes and summits on outwash plains and moraines. Areas are irregular in shape and range from 3 to about 30 acres in size.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is very dark brown sandy loam about 6 inches thick. The subsoil is about 14 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is brown and pale brown, calcareous sand. In some areas the surface soil is more than 17 inches thick. In other areas the underlying material is closer to the surface and contains more gravel. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are Forada and Hubbard soils, which make up 2 to 5 percent of the unit. The poorly drained Forada soils are in drainageways and depressions. The excessively drained Hubbard soils are on summits and side slopes.

Air and water move through the Sverdrup soil at a moderately rapid rate. Surface runoff is slow or medium in cultivated areas. The available water capacity and natural fertility are low. Organic matter content is moderate.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. The main management needs are measures that control water erosion, conserve moisture, and improve fertility. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure or returning crop residue to the soil improves fertility. If a good source of water is available, irrigation can minimize the droughtiness. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, little bluestem, indiangrass, smooth bromegrass, and orchardgrass. Water erosion is a hazard. Droughtiness also is a management concern. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, pasture rotation, timely deferment of grazing, applications of lime and fertilizer, weed control, and rotation grazing in the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

139B—Huntersville loamy sand, 1 to 4 percent slopes. This nearly level and gently sloping, moderately well drained soil is on plane or convex summits and toe slopes on sand-mantled drumlins in the uplands. Areas are irregularly shaped or elongated and range from 5 to 30 acres in size.

Typically, the surface layer is very dark brown and very dark grayish brown loamy sand about 6 inches thick. The subsurface layer is about 21 inches thick. The upper part is dark brown loamy sand, and the lower part is dark brown, mottled sand. The subsoil is dark yellowish brown and yellowish brown, mottled sandy loam about 26 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous sandy loam. In some areas the sandy surface soil is less than 20 or more than 40 inches thick.

Included with this soil in mapping are Blowers, Redeye, Rockwood, and Staples soils, which make up 5 to 15 percent of the unit. The moderately well drained Blowers soils are in landscape positions similar to those of the Huntersville soil. They do not have a sandy subsurface layer. The well drained Redeye and Rockwood soils are on rises and at the higher elevations. The poorly drained Staples soils are in drainageways and depressions.

Air and water move rapidly through the upper part of the Huntersville soil and very slowly through the underlying material. The available water capacity is moderate. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 2.5 to 4.0 feet. Organic matter content is moderately low or moderate. Natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland. A few are wooded. This soil is fairly well suited to most of the crops commonly grown in the county. Measures that reduce droughtiness, control erosion, and improve fertility are the main management needs. Applying a system of conservation tillage, returning crop residue to the soil, and including grasses and legumes in the cropping sequence conserve moisture and minimize erosion. Adding lime improves crop production.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include birdsfoot trefoil, smooth bromegrass, big bluestem, and indiangrass. Drought is a hazard. Erosion in the steeper areas and soil blowing in all areas are other hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, deferment of grazing during dry periods, applications of lime and fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIs. The woodland ordination symbol is 2S.

142—Nokay sandy loam. This nearly level, somewhat poorly drained soil is on ground moraines. It is in slightly concave areas at the base of slopes, on flats, and at the head of drainageways between drumlins. Areas are elongated and range from 5 to 50 acres in size.

Typically, the surface layer is very dark brown sandy loam about 5 inches thick. The subsurface layer is grayish brown, mottled sandy loam about 13 inches thick. The subsoil to a depth of about 60 inches is strong brown and brown, mottled sandy loam. In places free carbonates are in the underlying material. In some areas next to outwash plains, the surface layer is loamy sand.

Included with this soil in mapping are small areas of Alstad, Cushing, and Prebish soils, which make up 2 to 15 percent of the unit. The moderately well drained Alstad soils are on rises and the slightly higher parts of the landscape. The well drained Cushing soils are in the more sloping areas. The very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the upper part of the Nokay soil at a moderate or moderately rapid rate and through the lower part at a very slow rate. The available water capacity is high. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 1 to 3 feet. Organic matter content is moderate or high. Natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland. If drained, this soil is well suited to most of the crops commonly grown in the county. The main management needs are measures that reduce the wetness and improve fertility. A drainage system can reduce the wetness. Returning crop residue to the soil and applying manure, fertilizer, and lime improve fertility. In some areas surface stones interfere with cultivation. Rock picking may be needed to clear the stones from the fields.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include red clover, birdsfoot trefoil, smooth bromegrass, big bluestem, indiangrass, and switchgrass. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, restricted grazing during wet periods, applications of lime and fertilizer, weed control, and pasture rotation during the summer help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIw. The woodland ordination symbol is 4A.

144B—Flak sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on the convex crests and sides of drumlins and ground moraines. Areas are elongated and range from 5 to 50 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is dark brown sandy loam about 6 inches thick. The subsoil also is dark brown sandy loam. It is about 19 inches thick. The underlying material to a depth of about 60 inches is dark brown, firm sandy loam. In places the subsoil contains more clay. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Brainerd, Mahtomedi, Nokay, and Prebish soils, which make up 2 to 10 percent of the unit. The moderately well drained Brainerd soils are in the less sloping areas. The excessively drained, sandy Mahtomedi soils are in landscape positions similar to those of the Flak soil. The somewhat poorly drained Nokay soils are on flats and the upper parts of drainageways. The very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the upper part of the Flak soil at a moderately rapid rate and through the lower part at a very slow rate. The available water capacity is moderate. Surface runoff is medium in cultivated areas. Organic matter content is moderate. Natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. The main management needs are measures that control water erosion and remove surface stones. In some areas grassed waterways are needed to prevent gullying. Applying a system of conservation tillage, farming on the contour, terracing, returning crop residue to the soil, applying manure, and including grasses and legumes in the cropping sequence are effective in controlling erosion. In some areas surface stones interfere with cultivation. Rock picking may be needed to clear the stones from the fields. Applications of lime improve the effectiveness of fertilizer.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer and lime, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 3D.

144C—Flak sandy loam, 6 to 12 percent slopes. This sloping, well drained soil is on convex side slopes and nose slopes on drumlins and ground moraines. Areas are elongated and range from 5 to 20 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is dark brown sandy loam about 6 inches thick. The subsoil also is dark brown sandy loam. It is about 19 inches thick. The underlying material to a depth of about 60 inches is dark brown, firm sandy loam. In some areas the subsoil has more clay. In some small areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of Brainerd, Mahtomedi, Nokay, and Prebish soils, which make up 2 to 10 percent of the unit. The moderately well drained Brainerd soils are in the less sloping areas. The excessively drained, sandy Mahtomedi soils are in landscape positions similar to those of the Flak soil. The somewhat poorly drained Nokay soils are on flats and the upper parts of drainageways. The very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through upper part of the Flak soil at a moderately rapid rate and through the lower part at a very slow rate. The available water capacity is moderate. Surface runoff is medium in cultivated areas. Organic matter content is low. Natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. Controlling water erosion is the main management concern. Grassed waterways help to prevent gullying. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soil, terracing, applying manure, and including grasses and legumes in the cropping sequence are effective in controlling erosion. In some areas surface stones interfere with cultivation. Rock picking may be needed to clear the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. It can be controlled by a protective cover of grasses and legumes. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIe. The woodland ordination symbol is 3D.

158B—Zimmerman loamy fine sand, 1 to 6 percent slopes. This gently sloping, excessively drained soil is on outwash plains. Areas are irregular in shape and range from 5 to 150 acres in size.

Typically, the surface layer is black loamy fine sand about 4 inches thick. The subsurface layer is brown fine sand about 14 inches thick. The next 30 inches is yellowish brown and dark yellowish brown fine sand that has bands of dark brown loamy fine sand 0.25 inch to 1.5 inches thick. The underlying material to a depth of about 60 inches is brown and strong brown fine sand. In places the soil has a higher content of coarse sand. In some small areas the slope is less than 1 or more than 6 percent.

Included with this soil in mapping are small areas of DeMontreville and Mahtomedi soils, which make up 5 to 10 percent of the unit. These soils are on the higher parts of the landscape. The well drained DeMontreville soils have sandy loam glacial till at a depth of 20 to 40 inches. The excessively drained Mahtomedi soils have a higher content of coarse sand and gravel in the subsoil than the Zimmerman soil.

Air and water move through the Zimmerman soil at a rapid rate. The available water capacity is low. Surface runoff is medium or slow in cultivated areas. The content of organic matter and natural fertility are low.

Most areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. Droughtiness retards crop growth in most years. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure and returning crop residue to the soil improve fertility. If a good source of water is available, irrigation can minimize the droughtiness. The response of crops to irrigation is fair. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include smooth bromegrass, little bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of lime and fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. The loose, sandy surface layer limits the use of some equipment. The equipment becomes stuck easily. Maintaining a plant cover improves trafficability.

The land capability classification is IVs. The woodland ordination symbol is 2S.

158C—Zimmerman loamy fine sand, 6 to 15 percent slopes. This sloping and moderately steep, excessively drained soil is on ridges, knolls, and convex side slopes on outwash plains. Areas are irregular in shape and range from 5 to 35 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 3 inches thick. The subsurface layer is dark brown and pale brown fine sand about 27 inches thick. The subsoil and the underlying material to a depth of about 60 inches are yellowish brown, light yellowish brown, and pale brown fine sand that has bands of dark brown loamy fine sand 0.25 inch to 1.5 inches thick. In places the subsoil has a higher content of coarse sand. In some small areas the slope is less than 6 or more than 15 percent.

Included with this soil in mapping are small areas of DeMontreville and Mahtomedi soils, which make up 5 to 10 percent of the unit. The well drained DeMontreville soils are on concave summits and side slopes. They have sandy loam till at a depth of 20 to 40 inches. The excessively drained Mahtomedi soils are on convex side slopes and nose slopes. They have a higher content of coarse sand and gravel in the subsoil than the Zimmerman soil.

Air and water move through the Zimmerman soil at a rapid rate. The available water capacity is low. Surface runoff is medium or slow in cultivated areas. The content of organic matter and natural fertility are low.

Most areas are used as cropland. Some are used as woodland. This soil is generally unsuitable as cropland or pasture because of droughtiness and the hazard of soil blowing.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a high rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. The loose, sandy surface layer limits the use of equipment. The equipment becomes stuck easily. Maintaining a plant cover improves trafficability.

The land capability classification is VIs. The woodland ordination symbol is 2S.

163B—Brainerd sandy loam, 1 to 4 percent slopes. This nearly level and gently sloping, moderately well drained soil is in plane or slightly convex areas on knolls and flats on ground moraines and drumlins. Areas are irregular in shape and range from 5 to 70 acres in size.

Typically, the surface layer is very dark gray sandy loam about 8 inches thick. The subsurface layer is dark brown and dark grayish brown sandy loam about 10 inches thick. The subsoil is strong brown and dark brown, mottled sandy loam about 24 inches thick. The underlying material to a depth of about 60 inches is dark brown, mottled sandy loam. In a few areas the surface layer is thicker and darker. In some small areas the slope is less than 1 or more than 4 percent.

Included with this soil in mapping are small areas of Flak, Nokay, and Prebish soils, which make up 2 to 10 percent of the unit. The well drained Flak soils are in the steeper, higher areas. The somewhat poorly drained Nokay soils are in the less sloping areas and on flats. The very poorly drained Prebish soils are in depressions and swales.

Air and water move through the upper part of the Brainerd soil at a moderately rapid rate and through the lower part at a very slow rate. The available water capacity is moderate. Surface runoff is slow. A perched seasonal high water table is at a depth of 1.5 to 2.5 feet. Natural fertility is medium. Organic matter content is low or moderately low. The potential for frost action is moderate.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. Water erosion is the main hazard. Applying a system of conservation tillage, returning crop residue to the soil, and applying manure are effective in controlling erosion, maintaining fertility, minimizing crusting, and increasing the rate of water infiltration. Timely fieldwork is necessary. If used during wet periods, equipment can get stuck in this soft soil. Because of the number of surface stones, rock picking is common.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer and lime, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil.

Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 4A.

169B—Braham loamy sand, 1 to 6 percent slopes. This nearly level and gently sloping, well drained soil is on plane or convex summits, shoulder slopes, and back slopes on till plains and moraines. Areas range from 5 to 40 acres in size.

Typically, the surface layer is very dark gray loamy sand about 9 inches thick. The subsurface layer is brown sand about 15 inches thick. The subsoil is dark yellowish brown and yellowish brown silty clay loam about 16 inches thick. The underlying material to a depth of about 60 inches is yellowish brown silt loam. In some areas the sandy surface soil is less than 20 or more than 40 inches thick. In some small areas the slope is more than 6 percent.

Included with this soil in mapping are Blomford, Gonvick, and Roscommon soils, which make up 10 to 15 percent of the unit. The poorly drained Blomford soils and the poorly drained and very poorly drained Roscommon soils are in swales and drainageways. The moderately well drained Gonvick soils are at the higher elevations.

Air and water move through the upper part of the Braham soil at a rapid rate and through the underlying material at a moderate rate. The available water capacity is moderate. Surface runoff is slow or medium in cultivated areas. The content of organic matter is low or moderately low. Natural fertility is low or medium.

Most areas are used as cropland. A few are wooded. This soil is fairly well suited to most of the crops commonly grown in the county. Measures that reduce droughtiness, control erosion, and improve fertility are the main management needs. Applying a system of conservation tillage, returning crop residue to the soil, and including grasses and legumes in the cropping sequence conserve moisture and help to control erosion. Adding lime improves crop production.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include red clover, crownvetch, smooth bromegrass, little bluestem, and indiangrass. Drought is a hazard. Erosion in the steeper areas and soil blowing in all areas are other hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer and lime, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIs. The woodland ordination symbol is 3S.

170—Blomford loamy sand. This nearly level, poorly drained soil is in plane or concave areas along the edges of drainageways and depressions on glacial moraines and till plains. Areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is black loamy sand about 9 inches thick. The subsurface layer is mottled sand about 22 inches thick. The upper part is light brownish gray, and the lower part is grayish brown. The subsoil is olive gray, mottled silt loam. The underlying material to a depth of about 60 inches also is olive gray, mottled silt loam. In some areas the upper sandy material is more than 40 or less than 20 inches thick. In other areas the dark surface layer is thicker. In places the slope is more than 2 percent.

Included with this soil in mapping are small areas of Braham, Cathro, Eckvoll, and Nymore soils, which make up 5 to 10 percent of the unit. The well drained Braham and excessively drained Nymore soils are at the higher elevations and are more sloping than the Blomford soil. The very poorly drained Cathro soils are in depressions. The moderately well drained Eckvoll soils are in the higher, more sloping areas.

Air and water move at a rapid rate through the upper part of the Blomford soil and at a moderate rate through the lower part. The available water capacity is moderate. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet. Organic matter content is moderately low or moderate. Natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. If drained, this soil is fairly well suited to most of the crops commonly grown in the county. The main management needs are measures that reduce wetness. A drainage system can remove excess water if suitable outlets are available. Conservation tillage and applications of manure help to maintain tilth and the organic matter content.

If drained, this soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. Overgrazing or grazing when the soil is wet results in surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the wetness. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting activities are limited to periods when the ground is frozen. Seedling mortality is moderate because of the wetness. Selecting suitable species for planting helps to overcome this limitation. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIw. The woodland ordination symbol is 3W.

180—Gonvick loam. This nearly level, moderately well drained soil is on flats and slightly convex rises on moraines. Areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black loam about 12 inches thick. The subsoil is mottled loam about 20 inches thick. The upper part is dark brown, and the lower part is dark grayish brown. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some areas the dark surface soil is less than 8 inches thick. In Villard Township the soil formed in silty lacustrine material. In some small areas the slope is less than 1 or more than 3 percent.

Included with this soil in mapping are Flom and Waukon soils, which make up 5 to 10 percent of the unit. The poorly drained Flom soils are on toe slopes and in depressions and drainageways. The well drained Waukon soils are on the higher rises and knobs.

Air and water move through the Gonvick soil at a moderate rate. The available water capacity is high. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 2.5 to 6.0 feet. Organic matter content is moderate. Natural fertility is high. The potential for frost action also is high, and the shrink-swell potential is moderate.

Most areas are used as cropland. Some are wooded. This soil is well suited to most of the crops commonly grown in the county. Applying a system of conservation tillage, applying manure, and returning crop residue to the soil improve fertility and tilth and conserve moisture.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is I. The woodland ordination symbol is 4A.

183—Dassel mucky sandy loam. This nearly level, very poorly drained soil is in swales, on broad flats, and in former meltwater channels on outwash plains. It generally is subject to ponding. In Bruce and Little Elk Townships, however, it has been drained and channeled, so that the water table has been lowered and ponding seldom occurs. Areas are irregular in shape and range from 5 to 150 acres in size.

Typically, the surface layer is black mucky sandy loam about 9 inches thick. The subsurface layer is very dark gray, mottled fine sandy loam about 9 inches thick.

The subsoil is about 13 inches thick. It is stratified. It is dark grayish brown and very dark gray, mottled fine sandy loam in the upper part and dark grayish brown loamy fine sand in the lower part. The underlying material to a depth of about 60 inches is light brownish gray and light gray, calcareous, stratified fine sand and sand. In some areas the soil does not have a mucky surface layer and is more sandy. In other areas the surface layer has an accumulation of lime. In a few small areas, the subsoil has more clay.

Included with this soil in mapping are small areas of Bowstring and Markey soils, which make up 5 to 10 percent of the unit. These very poorly drained, organic soils are in swales and depressions.

Air and water move through the upper part of the Dassel soil at a moderately rapid rate and through the underlying material at a rapid rate. The available water capacity is high. Surface runoff is slow to ponded in cultivated areas. Natural fertility is medium. The seasonal high water table is 1 foot above to 1 foot below the surface. The content of organic matter is high or very high. The potential for frost action is high.

Most areas are used as pasture or hayland. If drained, this soil is fairly well suited to most of the crops commonly grown in the county. The main management needs are measures that reduce wetness and improve fertility. Surface drains or a combination of these drains and tile drainage can reduce the wetness, but some areas lack suitable outlets for drainage systems. If cultivated crops are grown, soil blowing is a hazard. It can be controlled by a conservation tillage system and winter cover crops. Applying fertilizer and manure or returning crop residue to the soil improves fertility and maintains tilth. Crops respond well to irrigation during periods of moisture stress.

This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. The best suited species are those that can withstand wet conditions. The major concerns in managing the pastured areas are overgrazing and grazing when the soil is wet. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to the development of wetland wildlife habitat. The habitat can be improved by introducing desirable plant species and by excavating shallow water areas.

The land capability classification is IIIw. No woodland ordination symbol is assigned.

200B—Holdingford sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on the slightly convex summits, shoulder slopes, back slopes, and side slopes of knolls on ground moraines and drumlins. Areas are elongated or irregular in shape and range from 4 to 40 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsurface layer is dark brown sandy loam about 7 inches thick. The next layer is grayish brown and dark reddish gray sandy loam about 5 inches thick. The subsoil is sandy loam about 34 inches thick. The upper part is dark brown, and the lower part is dark brown and yellowish brown. The underlying material to a depth of about 60 inches is yellowish brown, calcareous sandy loam. In some areas adjacent to outwash deposits, the soil has a sandy mantle as much as 15 inches thick. In other areas it does not have yellowish brown, calcareous glacial till. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Nokay and Prebish soils, which make up 2 to 15 percent of the unit. The somewhat poorly drained Nokay soils are in the upper parts of shallow drainageways and on flats. The very poorly drained Prebish soils are in depressions.

Air and water move through the Holdingford soil at a moderate rate. Surface runoff is medium in cultivated areas. The available water capacity is moderate. Organic matter content is moderately low. Natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. Water erosion is the major hazard. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soil, applying manure, and including grasses and legumes in the cropping sequence help to control erosion (fig. 8), improve fertility and tilth, and conserve moisture. In some areas surface stones interfere with cultivation. Rock picking may be necessary to remove the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff,

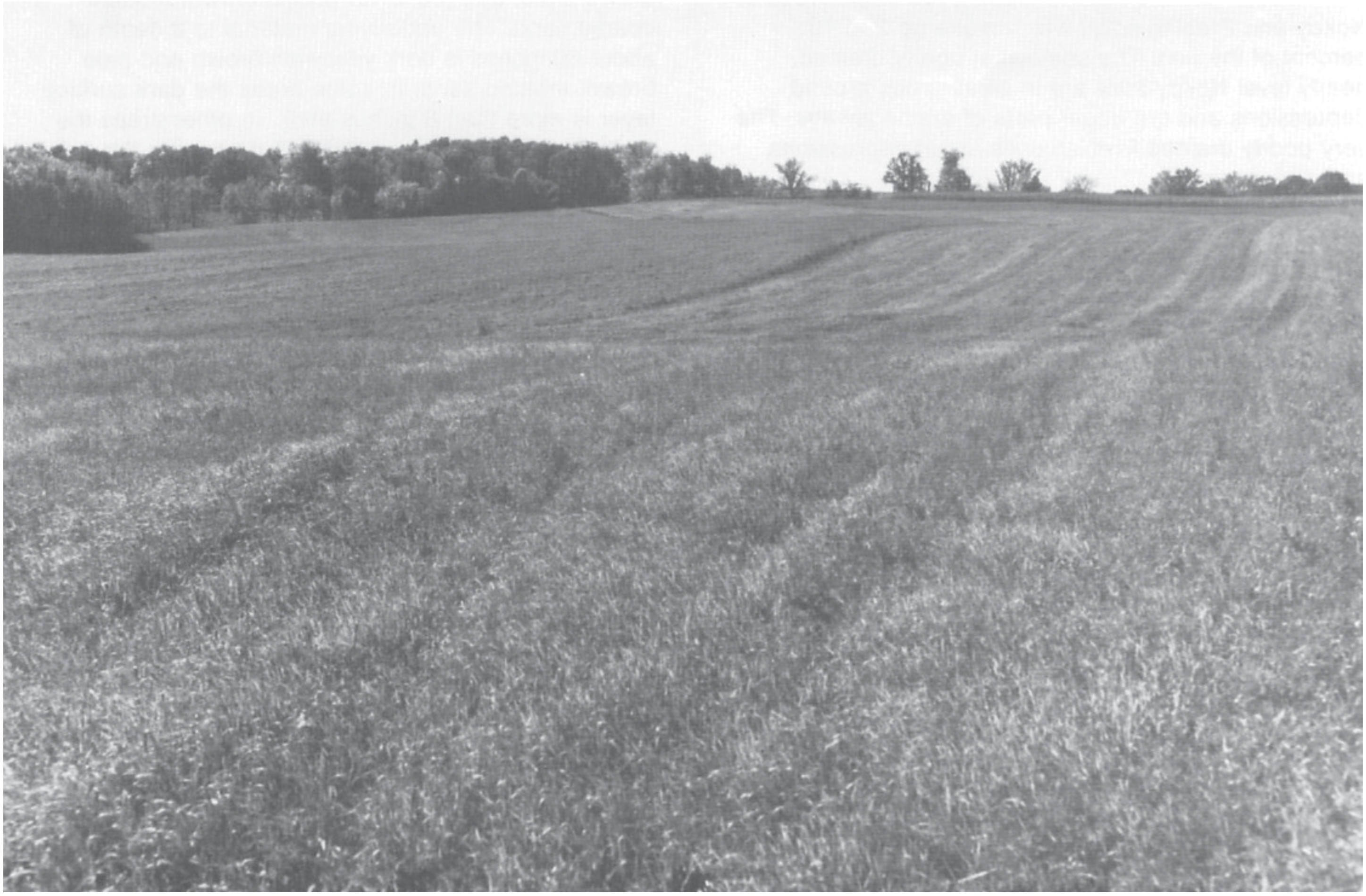

Figure 8.—A cover of grasses and legumes in an area of Holdingford sandy loam, 2 to 6 percent slopes.

and poor tilth. Proper stocking rates, applications of lime and fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 4A.

200C—Holdingford sandy loam, 6 to 12 percent slopes. This sloping, well drained soil is on convex side slopes and nose slopes on drumlins and ground moraines. Areas are elongated and range from 5 to 20 acres in size.

Typically, the surface layer is very dark gray and dark gray sandy loam about 7 inches thick. The subsurface layer is dark grayish brown and brown sandy loam about 12 inches thick. The subsoil is dark brown sandy loam about 37 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, calcareous sandy loam. In places the soil does not have yellowish brown, calcareous glacial till. In some areas the surface layer is thicker. In other areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of Nokay and Prebish soils, which make up 2 to 10 percent of the unit. The somewhat poorly drained, nearly level Nokay soils are in small areas around depressions and the upper parts of drainageways. The very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the Holdingford soil at a moderate rate. Surface runoff and natural fertility are medium. The available water capacity and the potential for frost action are moderate. Organic matter content is moderately low.

Most areas are used as cropland or pasture. This soil is fairly well suited to most of the crops commonly grown in the county. Water erosion is the major hazard. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soil, applying manure, and including grasses and legumes in the cropping sequence help to control erosion, improve fertility and tilth, and conserve moisture. In some areas surface stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

202—Meehan loamy sand. This nearly level, somewhat poorly drained soil is in shallow swales and on broad flats on outwash plains and stream terraces. Areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 8 inches thick. The subsoil is about 27 inches thick. The upper part is dark yellowish brown sand, and the lower part is brown, mottled coarse sand. The underlying material to a depth of about 60 inches is dark yellowish brown and pale brown, mottled sand. In some areas the dark surface layer is more than 8 inches thick. In other areas the content of gravel is more than 15 percent in the subsoil and underlying material.

Included with this soil in mapping are small areas of Isan, Menahga, and Roscommon soils, which make up 5 to 15 percent of the unit. The excessively drained Menahga soils are on toe slopes, foot slopes, and rises. The poorly drained and very poorly drained Isan and Roscommon soils are in swales and depressions.

Air and water move through the Meehan soil at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 1 to 3 feet. The content of organic matter is low or moderately low. Natural fertility is low. The potential for frost action is moderate.

Most areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. It also is suited to irrigated truck crops. The seasonal wetness and the low available water capacity are limitations, and soil blowing is a hazard. Excess water can be removed by open ditches or subsurface drainage lines. Applying a system of conservation tillage or planting a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure or returning crop residue to the soil improves fertility. If a good source of water is available, irrigation can minimize the droughtiness. The crops generally respond well to irrigation. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is fairly well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. The best suited species are those that can withstand the wet conditions. Overgrazing and grazing when the soil is wet results in surface compaction and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the wetness. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment.

Harvesting activities are limited to dry periods or periods when the ground is frozen. Seedling mortality is moderate because of the wetness. Selecting suitable species for planting helps to overcome this limitation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow.

The land capability classification is IVw. The woodland ordination symbol is 3W.

204B—Cushing sandy loam, 2 to 8 percent slopes. This gently undulating, well drained soil is on complex slopes on convex summits, side slopes, and head slopes on ground and end moraines. Areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 4 inches thick. The subsurface layer is dark brown sandy loam about 15 inches thick. The subsoil, which is about 30 inches thick, and the underlying material to a depth of about 60 inches also are dark brown sandy loam. In places they are coarser textured or are more yellow. In some areas the surface layer and subsoil are silty. In other areas the slope is less than 2 or more than 8 percent.

Included with this soil in mapping are small areas of Alstad, DeMontreville, Nokay, and Prebish soils, which make up 5 to 15 percent of the unit. The moderately well drained Alstad soils are in the less sloping areas. The well drained DeMontreville soils are on concave summits and side slopes. They have a sandy mantle that is 20 to 40 inches thick. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the Cushing soil at a moderate rate. The available water capacity also is moderate. Surface runoff is medium in cultivated areas. Organic matter content is moderately low. Natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. The major hazard is water erosion. Applying a system of conservation tillage, farming on the contour, returning residue to the soil, applying fertilizer and manure, and including grasses and legumes in the cropping sequence help to control erosion, maintain tilth and fertility, and conserve moisture. In places grassed waterways are needed to prevent gullying. In some areas surface stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, big bluestem, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of lime and fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 4A.

204C—Cushing sandy loam, 8 to 15 percent slopes. This undulating and rolling, well drained soil is in convex areas on side slopes, head slopes, and nose slopes on ground and end moraines. Areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray sandy loam about 3 inches thick. The subsurface layer is grayish brown sandy loam about 10 inches thick. The subsoil is dark yellowish brown and dark brown sandy loam about 39 inches thick. The underlying material to a depth of about 60 inches is dark brown sandy loam. In some areas the surface layer and subsoil are silty. In other areas the subsoil and underlying material have pockets of sand and gravel. In some small areas the slope is less than 8 or more than 15 percent.

Included with this soil in mapping are small areas of Alstad, DeMontreville, Nokay, and Prebish soils, which make up 5 to 15 percent of the unit. The moderately well drained Alstad soils are in the less sloping areas. The well drained DeMontreville soils are on concave summits and side slopes. They have a sandy mantle that is 20 to 40 inches thick. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the Cushing soil at a moderate rate. The available water capacity also is moderate. Surface runoff and natural fertility are medium. Organic matter content is moderately low. The potential for frost action is moderate.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. The major hazard is water erosion. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soil, applying manure, and including grasses and legumes in the cropping sequence help to control erosion, maintain tilth and fertility, and conserve moisture. In places grassed waterways are needed to prevent gullying. In some areas surface stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, big bluestem, red clover, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

204E—Cushing sandy loam, 15 to 45 percent slopes. This hilly to very steep, well drained soil is in convex areas on side slopes and nose slopes on ground and end moraines. Areas are irregular in shape and range from 3 to 30 acres in size.

Typically, the surface layer is very dark gray sandy loam about 3 inches thick. The subsurface layer is brown sandy loam about 14 inches thick. The subsoil is about 37 inches of dark brown sandy loam and sandy clay loam. The underlying material to a depth of about 60 inches is dark brown sandy clay loam. In places the subsoil and underlying material are coarser textured or are yellower. In some small areas the slope is less than 15 or more than 45 percent.

Included with this soil in mapping are small areas of Alstad, DeMontreville, Nokay, and Prebish soils, which make up 5 to 15 percent of the unit. The moderately well drained Alstad soils are in the less sloping areas at the head of drainageways. The well drained DeMontreville soils are on concave summits and side slopes. They have a sandy mantle that is 20 to 40 inches thick. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the Cushing soil at a moderate rate. The available water capacity also is moderate. Surface runoff and natural fertility are medium. Organic matter content is moderately low. The potential for frost action is moderate.

Most areas are used as woodland or as wooded pasture. This soil is generally unsuitable as cropland or pasture because of the slope, the hazard of erosion, and droughtiness.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. The normal effectiveness of windbreaks is impaired by the slope. The hazard of water erosion is severe unless a plant cover protects the site. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the slope. Erosion on logging roads and skid trails is a management concern. Building the roads and trails on the contour helps to control erosion. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is VIe. The woodland ordination symbol is 4R.

207B—Nymore loamy sand, 1 to 6 percent slopes. This nearly level and gently sloping, excessively drained soil is on slightly convex rises, knolls, and side slopes on outwash plains. Areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black loamy sand about 6 inches thick. The subsurface layer is dark brown loamy sand about 3 inches thick. The upper part of the subsoil is dark yellowish brown sand about 14 inches thick. The lower part is yellowish brown sand about 6 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown sand. In some areas the subsoil and underlying material contain more gravel. In other areas the soil has lime within a depth of 60 inches. In places the surface layer is thicker or thinner. In some small areas the slope is less than 1 or more than 6 percent.

Included with this soil in mapping are small areas of Duelm and Isan soils, which make up 5 to 15 percent of the unit. The surface layer of these soils is thicker than that of the Nymore soil. The somewhat poorly drained and moderately well drained Duelm soils are at the lower elevations. The poorly drained and very poorly drained Isan soils are in shallow depressions and drainageways.

Air and water move through the Nymore soil at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The content of organic matter is moderately low, and natural fertility is low.

Most areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. Droughtiness retards crop growth in most years. The main management needs are measures that conserve moisture and improve fertility. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure or returning crop residue to the soil improves fertility and increases the available water capacity. If a good source of water is available, irrigation can minimize the droughtiness. The response of crops to irrigation is fair. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, little bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of lime and fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVs. The woodland ordination is 3S.

207C—Nymore loamy sand, 6 to 12 percent slopes. This sloping, excessively drained soil is on ridges, knolls, and convex side slopes on outwash plains. Areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 5 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown loamy sand, and the lower part is dark yellowish brown sand. The underlying material to a depth of about 60 inches is dark yellowish brown sand. In some areas the subsoil and underlying material contain more gravel. In other areas the soil has lime within a depth of 60 inches. In places the surface layer is thicker or thinner. In some small areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of Duelm and Isan soils, which make up 5 to 10 percent of the unit. The moderately well drained and somewhat poorly drained Duelm soils are at the lower elevations. Their surface layer is thicker than that of the Nymore soil. The poorly drained and very poorly drained Isan soils are in shallow depressions and drainageways.

Air and water move through the Nymore soil at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The content of organic matter is moderately low, and natural fertility is low.

Most areas are used as cropland or woodland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. Droughtiness retards crop growth in most areas. The main management needs are measures that conserve moisture and improve fertility. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure and returning crop residue to the soil improve fertility. If a good source of water is available, irrigation can minimize the droughtiness. The response of crops to irrigation is fair. A traveling-gun system is the most commonly used method of irrigation.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, little bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of lime and fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVs. The woodland ordination symbol is 3S.

260—Duelm loamy sand. This nearly level, somewhat poorly drained and moderately well drained soil is in swales on outwash plains and stream terraces. Areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface soil is loamy sand about 15 inches thick. The upper part is black, and the lower part is very dark brown. The subsoil is about 29 inches thick. The upper part is dark grayish brown loamy sand, and the lower part is grayish brown, mottled coarse sand. The underlying material to a depth of about 60 inches is brown, mottled coarse sand. In some areas the surface soil and subsoil contain more clay. In other areas the surface soil is more than 20 inches thick. In places the content of gravel in the subsoil and underlying material is more than 15 percent. In some small areas the slope is more than 2 percent.

Included with this soil in mapping are small areas of Isan and Sverdrup soils, which make up 5 to 15 percent of the unit. The poorly drained and very poorly drained Isan soils are in swales and depressions. The well drained Sverdrup soils are on toe slopes and foot slopes.

Air and water move through the Duelm soil at a rapid rate. The available water capacity and natural fertility are low. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 2 to 5 feet. Organic matter content is moderately low. The potential for frost action is moderate.

Most areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. The main management needs are measures that conserve moisture and improve fertility. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure or returning crop residue to the soil improves fertility. If a good source of water is available, irrigation can minimize the droughtiness. The crops respond well to irrigation. Center-pivots and traveling-gun systems are the most common methods of irrigation.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of lime and fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVs. The woodland ordination symbol is 3S.

261—Isan loamy sand. This nearly level, poorly drained and very poorly drained soil is in depressions, in old drainageways, and on the edges of marshes on outwash plains. It is subject to ponding. Areas are elongated and range from 5 to 65 acres in size.

Typically, the surface layer is black loamy sand about 14 inches thick. The subsurface layer is very dark gray loamy sand about 5 inches thick. The subsoil is dark gray, mottled loamy sand about 8 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled sand. In places the soil has an organic surface layer as much as 6 inches thick.

Included with this soil in mapping are small areas of Duelm and Markey soils, which make up about 15 percent of the unit. The somewhat poorly drained and moderately well drained Duelm soils are on flats and on the rims of depressions. The very poorly drained Markey soils are in landscape positions similar to those of the Isan soil. They formed in organic material over sandy material.

Air and water move through the Isan soil at a rapid rate. The available water capacity is low. Surface runoff is slow to ponded in cultivated areas. The seasonal high water table is 0.5 foot above to 2.0 feet below the surface. Natural fertility is medium, and the organic matter content is high. The potential for frost action is moderate.

Most areas are used as pasture or hayland. This soil is poorly suited to most of the crops commonly grown in the county. The main management needs are measures that reduce wetness and improve fertility and tilth. Open drains or a combination of open drains and tile drains can reduce the wetness, but some areas lack suitable outlets for drainage systems. If cultivated crops are grown, soil blowing is a hazard. Conservation tillage and winter cover crops help to prevent excessive soil loss. Applying fertilizer and manure or returning crop residue to the soil improves fertility and tilth. Crops respond well to irrigation during periods of moisture stress.

This soil is fairly well suited to grasses and legumes for hay or pasture. The best suited species are those that can withstand the wet conditions. These include birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail. Overgrazing or grazing when the soil is wet causes surface compaction and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to wetland wildlife habitat. The habitat can be improved by introducing desirable plant species and by excavating shallow water areas.

The land capability classification is IVw. No woodland ordination symbol is assigned.

292—Alstad sandy loam. This nearly level and gently undulating, moderately well drained soil is in plane or slightly convex areas on ground moraines. Areas are irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsurface layer is dark grayish brown sandy loam about 5 inches thick. The subsoil is about 34 inches of dark brown and brown, mottled sandy clay loam and sandy loam. The underlying material to a depth of about 60 inches is dark brown, mottled sandy clay loam and sandy loam. In some areas the subsoil has less clay. In other areas the surface soil and subsoil are silty. In some small areas the slope is less than 1 or more than 4 percent.

Included with this soil in mapping are small areas of Cushing, Nokay, and Prebish soils, which make up 5 to 15 percent of the unit. The well drained Cushing soils are in the more sloping areas. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways. Also included are some areas where the soil has small pockets of sand and gravel.

Air and water move at a moderate rate through the upper part of the Alstad soil and at a moderately slow rate through the underlying material. The available water capacity is moderate. Organic matter content is moderately low. Surface runoff is slow in cultivated areas. A perched seasonal high water table is at a depth of 2 to 4 feet. Natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland or woodland. This soil is well suited to most of the crops commonly grown in the county. Erosion is the major hazard. The seasonal wetness is an additional management concern. It delays fieldwork in early spring. Applying a system of conservation tillage, returning crop residue to the soil, and applying manure help to control erosion, maintain tilth and fertility, and conserve moisture. In some areas surface stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, red clover, big bluestem, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of lime and fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 4A.

325—Prebish fine sandy loam. This level, very poorly drained soil is in slightly concave, shallow depressions, in swales, and on the margins of bogs on till plains and moraines. It is subject to ponding. Areas are generally elongated and range from 4 to 20 acres in size.

Typically, the surface layer is black fine sandy loam about 12 inches thick. The subsurface layer is very dark gray sandy loam about 5 inches thick. The subsoil is gray, mottled sandy loam about 28 inches thick. The underlying material to a depth of about 60 inches is dark brown, mottled sandy loam. In places the soil is shallow over firm till. In areas next to soils that formed in outwash, the surface layer is coarser textured.

Included with this soil in mapping are small areas of Alstad, Cathro, and Nokay soils, which make up 2 to 15 percent of the unit. The moderately well drained Alstad soils are in the more sloping areas next to the depressions. The very poorly drained Cathro soils are in the bogs. They formed in organic deposits over loamy material. The somewhat poorly drained Nokay soils are on flats and rises along the rims of the depressions.

Air and water move through the Prebish soil at a moderately slow rate. The available water capacity and organic matter content are high. Surface runoff is slow to ponded in cultivated areas. The seasonal high water table is 1 foot above to 1 foot below the surface. Natural fertility is low. The potential for frost action is high.

Most areas are pastured. This soil is poorly suited to most of the crops commonly grown in the county. The major hazards are ponding and frost, and the major limitation is wetness. The wetness can be overcome by a drainage system, but establishing outlets is difficult on this nearly level terrain. Ponding can be controlled by diversions and a surface drainage system. Because of its low landscape position, the soil is subject to frost in late spring and early fall. In some areas stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

This soil is fairly well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. The best suited species are those that can withstand the wet conditions. The major concerns in managing the pastured areas are overgrazing and grazing when the soil is wet. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the wetness. The use of equipment is limited during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting activities are limited to periods when the ground is frozen. Seedling mortality is moderate because of the wetness. Selecting suitable species for planting helps to overcome this limitation. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow.

This soil is well suited to the development of wetland wildlife habitat. It is suitable for the construction of impoundments, which can flood the soil. Shallow ponds can be dug for migratory waterfowl and elongated channels for furbearers.

The land capability classification is IVw. The woodland ordination symbol is 3W.

341A—Arvilla sandy loam, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on broad flats and slightly convex rises on outwash plains. Areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is black sandy loam about 16 inches thick. The subsurface layer is very dark gray sandy loam about 5 inches thick. The subsoil is dark brown sandy loam about 7 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and yellowish brown, calcareous, stratified sand

and gravelly sand. In some areas the depth to sand and gravelly sand is less than 15 inches. In other areas plowing has mixed the brownish subsoil with the surface layer. In some places the subsoil has more clay or more sand. In other places the surface layer is thinner and lighter colored. In some areas the soil has fewer coarse fragments throughout. In some small areas the slope is more than 2 percent.

Included with this soil in mapping are small areas of Forada and Osakis soils, which make up 5 to 10 percent of the unit. The poorly drained Forada soils are in swales and depressions. The moderately well drained Osakis soils are in swales and on flats.

Air and water move through the upper part of the Arvilla soil at a moderately rapid rate and through the underlying material at a rapid or very rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The content of organic matter is moderate, and natural fertility is medium.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. It is well suited to irrigated crops. The main management needs are measures that conserve moisture, control soil blowing, and improve fertility. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure and returning crop residue to the soil improve fertility. If a good source of water is available, irrigation can minimize the droughtiness. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, smooth bromegrass, little bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in soil blowing and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer and lime, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIs. No woodland ordination symbol is assigned.

341B—Arvilla sandy loam, 2 to 6 percent slopes. This gently sloping, somewhat excessively drained soil is on rises on outwash plains. Areas are irregular in shape and range from 4 to 40 acres in size.

Typically, the surface layer is black sandy loam about 11 inches thick. The subsurface layer is very dark gray and dark brown sandy loam about 5 inches thick. The subsoil is about 14 inches thick. The upper part is dark brown sandy loam and loamy sand, and the lower part is dark brown gravelly sand. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some areas the depth to coarse sand and gravelly sand is less than 15 inches. In other areas the subsoil has more clay or more sand. In places the surface layer is thinner and lighter colored. In a few areas the soil has fewer coarse fragments throughout. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Forada and Osakis soils, which make up 5 to 10 percent of the unit. The poorly drained Forada soils are in swales and depressions. The moderately well drained Osakis soils are in swales and on flats.

Air and water move through the upper part of the Arvilla soil at a moderately rapid rate and through the underlying material at a rapid or very rapid rate. The available water capacity is low. Surface runoff is medium in cultivated areas. The content of organic matter is moderate, and natural fertility is low.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. The main management needs are measures that conserve moisture, control soil blowing, and improve fertility. Applying a system of conservation tillage, applying manure, returning crop residue to the soil, and planting a winter cover crop help to control soil blowing, conserve moisture, and improve fertility. Irrigation can minimize droughtiness during the growing season.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, smooth bromegrass, little bluestem, and indiangrass. Droughtiness is a major limitation, and erosion in the steeper areas and soil blowing in all areas are hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

341C—Arvilla sandy loam, 6 to 12 percent slopes. This sloping, somewhat excessively drained soil is on convex slopes on outwash plains. Areas are irregular in shape and range from 3 to 25 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is very dark gray sandy loam about 5 inches thick. The subsoil is about 10 inches thick. The upper part is dark yellowish brown sandy loam, and the lower part is dark yellowish brown, calcareous coarse sand. The underlying material to a depth of about 60 inches is yellowish brown coarse sand. In some places the depth to coarse sand and gravel is less than 15 inches. In other places the subsoil contains more clay. In some areas the surface layer is thinner and lighter colored. In other areas the soil has fewer coarse fragments throughout or has more sand in the upper part. In some small areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of the moderately well drained Osakis soils, which make up 2 to 5 percent of the unit. These soils are in the lower swales and on flats.

Air and water move through the upper part of the Arvilla soil at a moderately rapid rate and through the underlying material at a rapid or very rapid rate. The available water capacity is low. Surface runoff is medium. The content of organic matter is moderate, and natural fertility is low.

Most areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. Droughtiness and water erosion are the main management concerns. Applying a system of conservation tillage, farming on the contour, applying manure, returning crop residue to the soil, and planting cover crops in the fall help to control erosion, conserve moisture, and maintain soil structure and tilth. Early maturing crops, such as small grain, can make better use of spring moisture than other crops.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, little bluestem, and indiangrass. Erosion, drought, and soil blowing are the major hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of lime and fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVe. No woodland ordination symbol is assigned.

374B—Rockwood sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex or concave summits, side slopes, and head slopes on drumlins. Areas are irregularly shaped or elongated and range from 5 to 200 acres in size. Slopes are 150 to 1,500 feet long.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is dark brown sandy loam about 8 inches thick. The subsoil is dark yellowish brown sandy loam about 30 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous, dense till that crushes to sandy loam. In some areas the subsoil is thicker and has more clay. In other areas the soil has small pockets of sand and gravel. In places the surface layer is thicker. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Blowers and Paddock soils, which make up 5 to 15 percent of the unit. The moderately well drained Blowers soils are in the slightly concave, less sloping areas and at the head of drainageways. The poorly drained and somewhat poorly drained Paddock soils are in drainageways and depressions.

Air and water move through the upper part of the Rockwood soil at a moderate rate and through the underlying material at a very slow rate. The available water capacity is moderate. Surface runoff is medium in cultivated areas. The content of organic matter is moderate, and natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. The main management concerns are measures that control water erosion. In some areas grassed waterways are needed to prevent gullying. Applying a system of conservation tillage, farming on the contour, stripcropping, including grasses and legumes in the cropping sequence, and returning crop residue to the soil are effective in controlling erosion. In some areas surface stones interfere with cultivation. Rock picking may be needed to clear the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, big bluestem, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer and lime, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 4A.

374C—Rockwood sandy loam, 6 to 12 percent slopes. This sloping, well drained soil is on convex side slopes and nose slopes on drumlins. Areas are irregularly shaped or elongated and range from 5 to 100 acres in size.

Typically, the surface layer is dark brown sandy loam about 6 inches thick. The subsurface layer is grayish brown sandy loam about 5 inches thick. The subsoil is dark yellowish brown and yellowish brown sandy loam about 23 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous, dense till that crushes to sandy loam. In some areas the subsoil contains more clay or is thinner. In other areas it has pockets or seams of sand and gravel. In places the surface layer is thicker. In some small areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of Blowers and Paddock soils, which make up 2 to 10 percent of the unit. The moderately well drained Blowers soils are on concave head slopes and in sloping drainageways. The somewhat poorly drained Paddock soils are in drainageways and depressions.

Air and water move through the upper part of the Rockwood soil at a moderate rate and through the underlying material at a very slow rate. The available water capacity is moderate. Surface runoff is medium or rapid in cultivated areas. The content of organic matter is moderate, and natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. Water erosion is the main management concern. Terraces, diversions, and grassed waterways help to control runoff, and contour farming, stripcropping, and cover crops help to control erosion and runoff. Returning crop residue to the soil and applying manure improve fertility, minimize crusting, and increase the rate of water infiltration. In some areas surface stones interfere with cultivation. Rock picking may be needed to clear the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, big bluestem, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

374D—Rockwood sandy loam, 12 to 25 percent slopes. This moderately steep and steep, well drained soil is on convex side slopes and nose slopes on drumlins. Areas are irregular in shape and range from 5 to 25 acres in size. Slopes are 50 to 300 feet long.

Typically, the surface layer is very dark brown sandy loam about 4 inches thick. The subsurface layer is dark grayish brown sandy loam about 16 inches thick. The subsoil is dark grayish brown, dark brown, and yellowish brown sandy loam about 22 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous, dense till that crushes to sandy loam. In some areas the subsoil has more clay or is thicker. In other areas it has pockets or seams of sand and gravel. In some small areas the slope is less than 12 or more than 25 percent.

Included with this soil in mapping are small areas of Blowers and Paddock soils, which make up 2 to 10 percent of the unit. The moderately well drained Blowers soils are on concave head slopes and in sloping drainageways. The somewhat poorly drained Paddock soils are in drainageways and depressions.

Air and water move through the upper part of the Rockwood soil at a moderate rate and through the underlying material at a very slow rate. The available water capacity is moderate. Surface runoff is rapid in cultivated areas. The content of organic matter is moderate, and natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland or pastured woodland. This soil is poorly suited to most of the crops commonly grown in the county. Water erosion is a major hazard. Diversions, contour farming, stripcropping, and a protective plant cover help to control erosion and runoff. Returning crop residue to the soil or applying manure improves fertility, minimizes crusting, and increases the rate of water infiltration. In some areas surface stones interfere with cultivation. Rock picking may be needed to clear the stones from the fields.

This soil is well suited to alfalfa, birdsfoot trefoil, big bluestem, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. The normal effectiveness of windbreaks is impaired by the slope. The hazard of erosion is severe unless a plant cover protects the site. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the slope. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVe. The woodland ordination symbol is 3R.

375—Forada sandy loam. This nearly level, poorly drained soil is in swales and on broad flats and the rims of depressions on outwash plains. Areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black sandy loam about 12 inches thick. The subsurface layer is very dark gray sandy loam about 6 inches thick. The subsoil is about 15 inches thick. It is dark grayish brown and grayish brown, mottled sandy loam in the upper part and dark grayish brown loamy sand in the lower part. The underlying material to a depth of about 60 inches is dark grayish brown and light brownish gray, mottled, calcareous coarse sand. In some areas the upper part of the soil has less clay. On some rises an accumulation of lime is on the surface. In some depressional areas the water table is closer to the surface.

Included with this soil in mapping are small areas of the moderately well drained Osakis soils, which make up 5 to 15 percent of the unit. These soils are on rises.

Air and water move through the upper part of the Forada soil at a moderately rapid rate and through the underlying material at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is medium, and the content of organic matter is high. The potential for frost action also is high.

Most areas are used as cropland. If drained, this soil is well suited to most of the crops commonly grown in the county. Unless irrigated, it is better suited to shallow-rooted, early maturing crops than to other crops. The main management needs are measures that reduce the wetness and improve fertility. Open ditches and subsurface drainage lines can remove excess water if suitable outlets are available. Returning crop residue to the soil or applying manure improves fertility and tilth and conserves moisture. Crops respond well to a balanced fertilization program. Because of the low available water capacity, irrigation is beneficial during periods of moisture stress.

If drained, this soil is well suited to reed canarygrass, Garrison creeping foxtail, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet results in surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw. No woodland ordination symbol is assigned.

402C—Sioux loamy sand, 2 to 12 percent slopes. This gently sloping and sloping, excessively drained soil is on convex side slopes, head slopes, and nose slopes on outwash plains and stream terraces. Areas are irregular in shape and range from 4 to 20 acres in size.

Typically, the surface layer is black loamy sand about 9 inches thick. The subsurface layer is very dark grayish brown loamy sand about 4 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and yellowish brown, calcareous gravelly sand. In some areas the surface layer has more gravel or is mildly alkaline. In other areas the content of gravel in the underlying material is less than 35 percent. In some small areas the slope is more than 12 percent.

Included with this soil in mapping are small areas of the somewhat excessively drained Arvilla soils on toe slopes and in swales. These soils make up 5 to 10 percent of the unit.

Air and water move through the Sioux soil at a rapid or very rapid rate. The available water capacity is low. Surface runoff is slow. Organic matter content is moderately low, and natural fertility is low.

Most areas are used as cropland or pasture. Because of droughtiness, this soil is generally unsuited to cultivated crops. It is suitable for such forage species as alfalfa, crownvetch, smooth bromegrass, intermediate wheatgrass, little bluestem, and sideoats grama. Pasture rotation, weed control, deferment of grazing until the grasses reach a minimum grazing height, and applications of fertilizer help to keep the pasture in good condition.

This soil is generally unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Seedling mortality is severe because of the moisture stress caused by the droughtiness. Onsite investigation may identify areas where trees and shrubs can be established if special management is applied.

The land capability classification is VIs. No woodland ordination symbol is assigned.

402E—Sioux loamy sand, 12 to 25 percent slopes. This moderately steep and steep, excessively drained soil is on convex side slopes, ridges, and valley sides on outwash plains and stream terraces. Areas are typically elongated and range from 4 to 15 acres in size.

Typically, the surface layer is black loamy sand about 8 inches thick. The subsurface layer is very dark grayish brown gravelly loamy sand about 5 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and yellowish brown, calcareous very gravelly coarse sand. In some areas the surface layer is yellowish brown gravelly sand. In other areas the content of gravel in the underlying material is less than 35 percent. In places the slope is less than 12 or more than 25 percent.

Included with this soil in mapping are small areas of the somewhat excessively drained Arvilla soils on toe slopes and in swales. These soils make up about 5 percent of the unit.

Air and water move through the Sioux soil at a rapid or very rapid rate. The available water capacity is low. Surface runoff is slow. Organic matter content is moderately low, and natural fertility is low.

Most areas are pastured or used as habitat for wildlife. Because of droughtiness and the slope, this soil is generally unsuited to cultivated crops and pasture and to the trees and shrubs grown as windbreaks and environmental plantings. Seedling mortality is severe because of the moisture stress caused by the droughtiness. Onsite investigation may identify areas where trees and shrubs can be established if special management is applied.

The land capability classification is VIs. No woodland ordination symbol is assigned.

406B—Dorset sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on outwash plains and moraines. It is on convex slopes and knolls that have short, uneven side slopes. Areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam, and the lower part is yellowish brown gravelly sand. The underlying material to a depth of about 60 inches is pale brown, calcareous gravelly coarse sand. In some areas the soil has a thicker subsoil and is deeper to free carbonates. On the crest of some slopes, it is coarser textured and is shallower to free carbonates. In places the surface layer is thicker. In the vicinity of Fawn Lake, the soil has a thinner dark surface layer and has a light colored subsurface layer. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Forada and Osakis soils, which make up 5 to 10 percent of the unit. The poorly drained Forada soils are in depressions and swales. The moderately well drained, nearly level Osakis soils are in concave areas.

Air and water move through the upper part of the Dorset soil at a moderately rapid rate and through the lower part at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. Organic matter content is moderate, and natural fertility is low.

Most areas are used as cropland. Some are used as wooded pasture. This soil is fairly well suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. The main management needs are measures that conserve moisture, control erosion, and improve fertility. Applying a system of conservation tillage, including grasses and legumes in the cropping sequence, and farming on the contour help to control runoff and erosion. Applying fertilizer and manure or returning crop residue to the soil improves fertility and tilth. Irrigation is needed, but a good source of water is not readily available.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, little bluestem, intermediate wheatgrass, smooth bromegrass, big bluestem, and indiangrass. Droughtiness is a major limitation, and erosion in the steeper areas and soil blowing in all areas are hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer and lime, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock.

The land capability classification is IIIs. The woodland ordination symbol is 2S.

406C—Dorset sandy loam, 6 to 12 percent slopes. This rolling, well drained soil is on complex, short, uneven side slopes on outwash plains and moraines. Areas are elongated and range from 3 to 30 acres in size.

Typically, the surface layer is dark brown sandy loam about 6 inches thick. The subsoil is about 24 inches thick. The upper part is dark yellowish brown sandy loam, and the lower part is yellowish brown gravelly sand. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some areas the subsoil is thicker, is deeper to free carbonates, and has fewer coarse fragments. On the crest of some slopes, the soil is coarser textured and is shallower to free carbonates. In places the surface layer is thicker. In the vicinity of Fawn Lake, the soil has a thinner dark surface layer and has a light colored subsurface layer. In some small areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of the moderately well drained Osakis soils. These soils are in low, concave areas. They make up 5 to 10 percent of the unit.

Air and water move through the upper part of the Dorset soil at a moderately rapid rate and through the lower part at a rapid rate. The available water capacity is low. Surface runoff is medium in cultivated areas. Organic matter content is moderate, and natural fertility is medium.

Most areas are used as cropland. Some are used as pasture or woodland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. The main management needs are measures that control erosion, conserve moisture, and improve fertility. Applying a system of conservation tillage, including grasses and legumes in the cropping sequence, and farming on the contour or stripcropping help to control runoff and erosion. Applying fertilizer and manure or returning crop residue to the soil improves fertility and tilth.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, little bluestem, smooth bromegrass, switchgrass, and big bluestem. Erosion, drought, and soil blowing are the major hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock.

The land capability classification is IVe. The woodland ordination symbol is 2S.

413—Osakis sandy loam. This nearly level, moderately well drained soil is on broad flats and low rises on outwash plains. Areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is black sandy loam about 13 inches thick. The subsoil is about 10 inches thick. It is very dark grayish brown and mottled. The upper part is sandy loam, and the lower part is gravelly loamy sand. The underlying material to a depth of about 60 inches is light brownish gray and yellowish brown, mottled, calcareous gravelly coarse sand. In some areas the depth to sand and gravel is less than 12 or more than 20 inches.

Included with this soil in mapping are small areas of Arvilla, Dorset, Forada, and Hangaard soils, which make up 3 to 10 percent of the unit. The somewhat excessively drained Arvilla and well drained Dorset soils are on rises. The poorly drained Forada and Hangaard soils are in swales and small depressions.

Air and water move through the upper part of the Osakis soil at a moderate or moderately rapid rate and through the lower part at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 3 to 6 feet. The content of organic matter is moderate, and natural fertility is medium. The potential for frost action is moderate.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. It is well suited to irrigated crops. The main management needs are measures that conserve moisture, control soil blowing, and improve fertility. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure or returning crop residue to the soil improves fertility. If a good source of water is available, irrigation can minimize the droughtiness. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, smooth bromegrass, big bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in soil blowing and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIs. No woodland ordination symbol is assigned.

421B—Ves loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on rises, side slopes, and ridges on ground moraines and till plains. Areas are irregular in shape and typically range from 5 to 50 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is mixed very dark brown and black loam about 5 inches thick. The subsoil is dark yellowish brown and olive brown loam about 21 inches thick. It is calcareous in the lower part. The underlying material to a depth of about 60 inches is olive brown, calcareous loam. In some areas the surface soil is thinner or has been mixed with the brownish subsoil by plowing. On some knobs the surface layer is light colored and has free carbonates. In places the upper part of the underlying material does not have an accumulation of lime. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Normania and Flom soils, which make up 5 to 15 percent of the unit. The poorly drained Flom soils are in swales and drainageways and on toe slopes. The moderately well drained Normania soils are in the less sloping, convex areas.

Air and water move through the Ves soil at a moderate rate. The available water capacity is high. Surface runoff is medium in cultivated areas. The content of organic matter is moderate or high, and natural fertility is high. The potential for frost action and the shrink-swell potential are moderate.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. The main management needs are measures that control water erosion and improve fertility and tilth. Applying a system of conservation tillage, returning crop residue to the soil, and including grasses and legumes in the cropping sequence are effective in controlling erosion and improving tilth. In some areas grassed waterways are needed to prevent gullying.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe. No woodland ordination symbol is assigned.

421C—Ves loam, 6 to 12 percent slopes. This sloping, well drained soil is on ridges and convex side slopes on ground moraines and till plains. Areas are irregular in shape and range from 3 to 25 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is mixed very dark brown and black loam about 5 inches thick. The subsoil is loam about 11 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the surface layer is thinner or has been mixed with the brownish subsoil by plowing. In other areas the upper part of the underlying material does not have an accumulation of lime. In some small areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of the well drained Langhei soils, which make up 5 to 10 percent of the unit. These soils are on the steeper, convex slopes.

Air and water move through the Ves soil at a moderate rate. The available water capacity is high. Surface runoff is medium or slow in cultivated areas. Organic matter content is moderate or high, and natural fertility is high. The potential for frost action and the shrink-swell are moderate.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. The main management needs are measures that control water erosion and improve fertility and tilth. Applying a system of conservation tillage, stripcropping, and including grasses and legumes in the cropping sequence are effective in controlling erosion. In some areas grassed waterways are needed to prevent gullying. Applying fertilizer and manure or returning crop residue to the soil improves fertility and tilth.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

446—Normania loam. This nearly level and gently sloping, moderately well drained soil is on broad flats and low rises on ground moraines and till plains. Areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is black loam about 12 inches thick. The subsoil is dark grayish brown and grayish brown loam about 27 inches thick. In the lower part it is mottled and has an accumulation of lime. The underlying material to a depth of about 60 inches is light yellowish brown and grayish brown, mottled, calcareous loam. In some areas the surface layer is thinner.

Included with this soil in mapping are areas of Bluffton, Flom, and Ves soils, which make up 5 to 10 percent of the unit. The very poorly drained Bluffton soils are in small, closed depressions. The poorly drained Flom soils are in swales and drainageways. The well drained Ves soils are on the steeper slopes and rises.

Air and water move through the Normania soil at a moderate rate. The available water capacity is high. Surface runoff is medium or slow in cultivated areas. The seasonal high water table is at a depth of 2.5 to 6.0 feet. The content of organic matter and natural fertility are high. The potential for frost action is high, and the shrink-swell potential is moderate.

Most areas are used as cropland. This soil is well suited to all of the crops commonly grown in the county. Applying a system of conservation tillage, applying manure, and returning crop residue to the soil improve fertility and tilth and conserve moisture.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is I. No woodland ordination symbol is assigned.

453B—DeMontreville loamy sand, 2 to 8 percent slopes. This undulating, well drained soil is on convex or concave summits, side slopes, and head slopes on ground and end moraines. Areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark brown loamy sand about 3 inches thick. The subsurface layer is dark brown loamy sand about 20 inches thick. The subsoil is sandy loam about 25 inches thick. The upper part is dark yellowish brown, and the lower part is dark brown. The underlying material to a depth of about 60 inches is dark brown sandy loam. In some small areas the sandy material is more than 40 inches thick. In a few areas the slope is less than 2 or more than 8 percent.

Included with this soil in mapping are small areas of Alstad, Cushing, Nokay, and Prebish soils, which make up 5 to 15 percent of the unit. The moderately well drained Alstad soils are in the less sloping areas. The well drained Cushing soils are in landscape positions similar to those of the DeMontreville soil. They formed in loamy glacial till. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the upper part of the DeMontreville soil at a rapid rate and through the underlying material at a moderately slow rate. The available water capacity is moderate. Surface runoff is medium in cultivated areas. Organic matter content and natural fertility are low.

Most areas are used as cropland. This soil is fairly well suited to most of the crops commonly grown in the county. Measures that reduce droughtiness, control water erosion, and improve fertility are the main management needs. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soil, applying manure, and including grasses and legumes in the cropping sequence are effective in controlling erosion, improving tilth and fertility, and conserving moisture. In some areas grassed waterways are needed to prevent gullying. In other areas surface stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, big bluestem, and indiangrass. Drought is a hazard. Erosion in the steeper areas and soil blowing in all areas are other hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, deferment of grazing during dry periods, applications of lime and fertilizer, weed control, and rotation grazing help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Careful planting of suitable vigorous nursery stock helps to overcome this limitation.

The land capability classification is IIIs. The woodland ordination symbol is 4S.

453C—DeMontreville loamy sand, 8 to 15 percent slopes. This rolling, well drained soil is on convex or concave side slopes, head slopes, and nose slopes on ground and end moraines. Areas are irregular in shape and range from 3 to 25 acres in size.

Typically, the surface layer is very dark brown loamy sand about 2 inches thick. The subsurface layer is dark grayish brown loamy sand about 16 inches thick. The subsoil is about 16 inches thick. The upper part is yellowish brown and brown loamy sand, and the lower part is dark brown sandy loam. The underlying material to a depth of about 60 inches is dark brown coarse sandy loam. In some areas the sandy material is more than 40 inches thick. In some small areas the slope is less than 8 or more than 15 percent.

Included with this soil in mapping are small areas of Alstad, Cushing, Nokay, and Prebish soils, which make up 5 to 15 percent of the unit. The moderately well drained Alstad soils are in the less sloping areas. The well drained Cushing soils formed in loamy glacial till. They are in positions on the landscape similar to those of the DeMontreville soil. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the upper part of the DeMontreville soil at a rapid rate and through the underlying material at a moderately slow rate. The available water capacity is moderate. Surface runoff is medium in cultivated areas. Organic matter content and natural fertility are low.

Most areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. The main management needs are measures that control water erosion and reduce droughtiness. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soil, applying manure, and including grasses and legumes in the cropping sequence help to control erosion, improve tilth and fertility, and conserve moisture. In places grassed waterways are needed to prevent gullying. In some areas surface stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, red clover, big bluestem, smooth bromegrass, and orchardgrass. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet results in surface compaction, excessive runoff, erosion, deterioration of the pasture, and poor tilth. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, and deferment of grazing until the grasses reach a minimum grazing height help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Careful planting of suitable vigorous nursery stock helps to overcome this limitation.

The land capability classification is IVe. The woodland ordination symbol is 4S.

454B—Mahtomedi loamy sand, 1 to 8 percent slopes. This nearly level to rolling, excessively drained soil is on convex side slopes, nose slopes, and head slopes on ground moraines and outwash plains. Areas are irregular in shape and range from 4 to 40 acres in size.

Typically, the surface is very dark brown loamy sand about 5 inches thick. The subsurface layer is dark brown loamy sand about 6 inches thick. The subsoil is stratified dark brown and strong brown gravelly coarse sand about 12 inches thick. The underlying material to a depth of about 60 inches is stratified strong brown and dark brown sand and gravelly coarse sand. In some areas the content of coarse fragments is less than 10 or more than 35 percent. In some small areas the slope is more than 8 percent.

Included with this soil in mapping are small areas of the well drained Cushing, DeMontreville, and Holdingford soils, which make up 5 to 15 percent of the unit. Cushing soils are on complex, convex summits and side slopes. They formed entirely in loamy glacial till. DeMontreville soils are on concave summits and side slopes. They have a sandy mantle that is 20 to 40 inches thick. Holdingford soils are on slightly convex summits and shoulder slopes. They have calcareous, loamy material at a depth of 36 to 60 inches.

Air and water move through the Mahtomedi soil at a rapid rate. The available water capacity is very low or low. Surface runoff is medium in cultivated areas. Organic matter content and natural fertility are low.

Most areas are used as cropland or pasture. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. The main management needs are measures that conserve moisture and improve fertility. Examples are returning crop residue to the soil and applying manure and fertilizer.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, little bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer and lime, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. The loose, sandy surface layer limits the use of equipment. The equipment becomes stuck easily. Maintaining a plant cover improves trafficability. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVs. The woodland ordination symbol is 2S.

454C—Mahtomedi loamy coarse sand, 8 to 15 percent slopes. This rolling and hilly, excessively drained soil is on convex side slopes, head slopes, and nose slopes on ground moraines and outwash plains. Areas are irregular in shape and range from 4 to 50 acres in size.

Typically, the surface layer is black loamy coarse sand about 2 inches thick. The subsurface layer is very dark grayish brown coarse sand about 3 inches thick. The subsoil is dark brown coarse sand about 20 inches thick. The underlying material to a depth of about 60 inches is stratified, brown coarse sand. In some areas the content of gravel is less than 10 or more than 35 percent. In other areas the slope is less than 8 or more than 15 percent.

Included with this soil in mapping are small areas of the well drained Cushing and DeMontreville soils, which make up 5 to 15 percent of the unit. Cushing soils are on complex, convex summits and side slopes. They formed entirely in loamy glacial till. DeMontreville soils are on concave summits and side slopes. They have a sandy mantle that is 20 to 40 inches thick.

Air and water move through the Mahtomedi soil at a rapid rate. The available water capacity is very low or low. Surface runoff is medium. Organic matter content and natural fertility are low.

Most areas are used as cropland. Some are used as woodland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. Droughtiness retards crop growth in most years. Conservation tillage or a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure and returning crop residue to the soil improve fertility. If a good source of water is available, irrigation can minimize the droughtiness. The response of crops to irrigation is fair. A traveling-gun system is the most common method of irrigation.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include smooth bromegrass, little bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, application of lime and fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Selecting suitable species for planting helps to overcome this limitation. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a high rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. The loose, sandy surface layer limits the use of equipment. The equipment becomes stuck easily. Maintaining a plant cover improves trafficability. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVs. The woodland ordination symbol is 2S.

454E—Mahtomedi loamy coarse sand, 15 to 45 percent slopes. This moderately steep to very steep, excessively drained soil is on convex side slopes and nose slopes on ground moraines and outwash plains. Areas are irregular in shape and range from 4 to 25 acres in size.

Typically, the surface layer is black loamy coarse sand about 2 inches thick. The subsurface layer is very dark grayish brown coarse sand about 2 inches thick. The subsoil is dark brown coarse sand about 18 inches thick. The underlying material to a depth of about 60 inches is brown and dark brown, stratified coarse sand. In some areas the content of gravel is less than 10 or more than 35 percent. In other areas the slope is less than 15 or more than 45 percent.

Included with this soil in mapping are small areas of the well drained Cushing and DeMontreville soils, which make up 10 to 15 percent of the unit. Cushing soils are on complex, convex summits and side slopes. They formed entirely in noncalcareous glacial till. DeMontreville soils are on concave summits and side slopes. They have a sandy mantle that is 24 to 40 inches deep over loamy glacial till.

Air and water move through the Mahtomedi soil at a rapid rate. The available water capacity is low. Surface runoff is medium. Organic matter content and natural fertility are low.

Most areas are used as pasture or woodland. This soil is generally unsuitable as cropland or pasture because of droughtiness, the slope, and a severe hazard of erosion.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. The slope limits the effectiveness of windbreaks. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Erosion is a severe hazard unless a plant cover protects the surface and site preparation is limited to the area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the slope. Erosion is a hazard on logging roads and skid trails. It can be controlled by building the roads and trails on the contour. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. The droughtiness causes a high rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is VIIs. The woodland ordination symbol is 2R.

458B—Menahga loamy sand, 2 to 6 percent slopes. This gently sloping, excessively drained soil is on ridges, knolls, and convex side slopes on outwash plains and valley trains. Areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 3 inches thick. The subsoil is sand about 26 inches thick. The upper part is yellowish brown, and the lower part is dark yellowish brown. The underlying material to a depth of about 60 inches is light yellowish brown sand. In some areas the subsoil and underlying material contain more gravel. In other areas lime is within a depth of 60 inches. In places the surface layer is thicker. In some small areas the slope is less than 2 or more than 6 percent.

Included with this soil in mapping are small areas of Meehan and Roscommon soils, which make up 5 to 10 percent of the unit. The somewhat poorly drained Meehan soils are on broad flats. The poorly drained and very poorly drained Roscommon soils are in depressions and drainageways.

Air and water move through the Menahga soil at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The content of organic matter is moderately low or low, and natural fertility is low.

Most areas are wooded. Some are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. Droughtiness retards crop growth in most years. The main management needs are measures that conserve moisture and improve fertility. Applying a system of conservation tillage or growing a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure or returning crop residue to the soil improves fertility. If a good source of water is available, irrigation can minimize the droughtiness. The response of crops to irrigation is fair. Center-pivot and traveling-gun systems are the most common methods of irrigation.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include birdsfoot trefoil, red clover, smooth bromegrass, little bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer and lime, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality.

Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. The loose, sandy surface layer limits the use of equipment. The equipment becomes stuck easily. Maintaining a good plant cover improves trafficability.

The land capability classification is IVs. The woodland ordination symbol is 2S.

458C—Menahga loamy sand, 6 to 12 percent slopes. This sloping, excessively drained soil is on ridges, knolls, and convex side slopes on outwash plains and valley trains. Areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 3 inches thick. The subsoil is about 29 inches thick. The upper part is brown loamy sand, and the lower part is yellowish brown sand. The underlying material to a depth of about 60 inches is yellowish brown sand. In some areas the subsoil and underlying material contain more gravel. In other areas lime is within a depth of 60 inches. In places the surface layer is thicker. In some small areas the slope is less than 6 or more than 12 percent.

Included with this soil in mapping are small areas of the somewhat poorly drained, nearly level Meehan soils in concave swales and on broad flats. These soils make up 5 to 10 percent of the unit.

Air and water move through the Menahga soil at a rapid rate. The available water capacity is low. Surface runoff is slow in cultivated areas. The content of organic matter is low or moderately low, and natural fertility is low.

Most areas are used as woodland. Some areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. It is better suited to shallow-rooted, early maturing crops than to other crops. Droughtiness retards crop growth in most areas. The main management needs are measures that conserve moisture, control soil blowing, and improve fertility. Applying a system of conservation tillage or growing a winter cover crop conserves moisture and helps to control soil blowing. Applying fertilizer and manure or returning crop residue to the soil improves fertility. If a good source of water is available, irrigation can minimize the droughtiness. The response of crops to irrigation is fair.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include birdsfoot trefoil, red clover, smooth bromegrass, big bluestem, and indiangrass. Droughtiness is a major limitation, and soil blowing is a hazard. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a high rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. The loose, sandy surface layer limits the use of equipment. The equipment becomes stuck easily. Maintaining a good plant cover improves trafficability.

The land capability classification is IVs. The woodland ordination symbol is 2S.

458E—Menahga loamy sand, 12 to 25 percent slopes. This moderately steep and steep, excessively drained soil is on ridges and knolls on outwash plains and valley trains. Areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 4 inches thick. The subsoil is brown sand about 24 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown sand. In some places the subsoil and underlying material contain more gravel. In other places lime is within 60 inches of the surface. In some areas the surface layer is thicker. In other areas the slope is less than 12 or more than 25 percent.

Air and water move through this soil at a rapid rate. The available water capacity is low. Surface runoff is medium. The content of organic matter is low or moderately low, and natural fertility is low.

Most areas are used as woodland or as wooded pasture. Because of the slope and droughtiness, this soil is generally unsuited to cropland. Suitable species for pasture and hay include birdsfoot trefoil, red clover, smooth bromegrass, big bluestem, little bluestem, and sideoats grama. Pasture rotation, weed control, deferment of grazing until the grasses reach a minimum grazing height, and applications of lime and fertilizer help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. The slope limits the effectiveness of windbreaks. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. Erosion is a severe hazard unless a plant cover protects the surface and site preparation is limited to the area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the slope. Erosion is a hazard on logging roads and skid trails. It can be controlled by building the roads and trails on the contour. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. The droughtiness causes a high rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock.

The land capability classification is VIs. The woodland ordination symbol is 2R.

514—Tacoosh mucky peat. This nearly level, very poorly drained soil is in depressional areas and in areas between drumlins on moraines and till plains. It is subject to ponding. Areas are circular or oblong and range from 5 to 500 acres in size.

Typically, the surface layer is black mucky peat about 9 inches thick. The subsurface layer is dark brown and black mucky peat about 21 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown and grayish brown, mottled sandy loam.

Included with this soil in mapping are the very poorly drained Cathro, Markey, and Rifle soils, which make up 2 to 10 percent of the unit. These soils are in landscape positions similar to those of the Tacoosh soil. Cathro soils formed in organic material over loamy material. Markey soils formed in organic material over sandy material. Rifle soils are mucky peat to a depth of more than 51 inches.

Air and water move through the organic part of the Tacoosh soil at a moderately rapid rate and through the underlying material at a moderate rate. The available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is 1 foot above to 1 foot below the surface. Organic matter content is very high. Natural fertility is medium. The potential for frost action is high.

Most areas are used as unimproved pasture or as wildlife habitat. This soil is poorly suited to most of the crops commonly grown in the county. The wetness and the hazard of soil blowing are the main management concerns. An adequate drainage system can remove excess water and thus permit earlier planting, but drainage outlets are not readily available in most areas. Because of the low position on the landscape, frost can damage crops.

This soil is fairly well suited to grasses and legumes for hay or pasture. It is best suited to the forage species that can withstand wet conditions. These species include reed canarygrass and Garrison creeping foxtail. Overgrazing or grazing when the soil is wet causes compaction and deterioration of the pasture. Proper stocking rates, an adequate drainage system, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the wetness. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment. The equipment can easily become bogged down in the organic material because of the wetness. Harvesting equipment should be used only when the ground is frozen. The seedling mortality rate is high. It can be reduced by selecting water-tolerant species for planting. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

This soil is well suited to wetland wildlife habitat. It provides good habitat for waterfowl, furbearers, and big and small game. Developing areas of open water improves the habitat.

The land capability classification is IVw in drained areas, VIw in undrained areas. The woodland ordination symbol is 4W.

540—Seelyeville muck. This nearly level, very poorly drained soil is in depressions and potholes on moraines and outwash plains. It is subject to ponding. Areas are circular or oblong and range from 10 to 100 acres in size.

Typically, the surface layer is black muck about 10 inches thick. The underlying material to a depth of about 60 inches is very dark gray and very dark grayish brown muck. In some areas the muck is less than 51 inches thick. In other areas the surface layer is mildly alkaline or is mucky peat.

Included with this soil in mapping are the very poorly drained Rondeau soils, which make up 5 to 20 percent of the unit. These soils are in landscape positions similar to those of the Seelyeville soil. They have coprogenous earth 16 to 51 inches below the surface.

Air and water move through the Seelyeville soil at a moderately rapid to moderately slow rate. The available water capacity is very high. Surface runoff is very slow or ponded in cultivated areas. The seasonal high water table is 1 foot above to 2 feet below the surface. Organic matter content is very high, and natural fertility is medium. The potential for frost action is high.

Most areas are used as unimproved pasture or as wildlife habitat. This soil is poorly suited to most of the crops commonly grown in the county. The wetness and the hazard of soil blowing are the main management concerns. Open ditches can remove excess water and thus permit earlier planting and minimize the crop damage caused by ponding, but drainage outlets are not readily available in some areas. Because of the low landscape position, frost can damage crops.

This soil is fairly well suited to grasses and legumes for hay or pasture. It is best suited to the forage species that can withstand wet conditions. These species include reed canarygrass and Garrison creeping foxtail. Overgrazing or grazing when the soil is wet causes compaction and deterioration of the pasture. Proper stocking rates, an adequate drainage system, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the wetness. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting equipment should be used only when the ground is frozen. The equipment can easily become bogged down in the organic material. Because of the wetness, the seedling mortality rate is high. It can be reduced by selecting water-tolerant species for planting. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

This soil is well suited to wetland wildlife habitat. It provides good habitat for waterfowl, furbearers, and big and small game. Developing areas of open water improves the habitat.

The land capability classification is IVw in drained areas, VIw in undrained areas. The woodland ordination symbol is 4W.

541—Rifle muck. This nearly level, very poorly drained soil is in bogs, potholes, and large depressions on till plains, outwash plains, and moraines. It is subject to ponding. Areas are irregular in shape and range from 30 to 200 acres in size.

Typically, the surface layer is black muck about 9 inches thick. Below this to a depth of about 60 inches is dark brown and brown mucky peat. In some small areas loamy material is within a depth of 51 inches. In other areas the soil is dominantly peat or muck.

Included with this soil in mapping are small areas of Cathro, Markey, and Rondeau soils, which make up 2 to 10 percent of the unit. These soils are in landscape positions similar to those of the Rifle soil. Cathro and Markey soils are underlain by loamy or sandy material within a depth of 51 inches. Rondeau soils are underlain by coprogenous earth.

Air and water move through the Rifle soil at a moderate or moderately rapid rate. The available water capacity and organic matter content are very high. Surface runoff is very slow or ponded. The seasonal high water table is 1 foot above to 1 foot below the surface. Natural fertility is medium. The potential for frost action is high.

Most areas support native vegetation, wild hay, or pasture plants and are used as unimproved pasture or as wildlife habitat. A few areas are used as cropland. This soil is poorly suited to most of the crops commonly grown in the county. The wetness and soil blowing are the main management concerns. The wetness can be reduced by a drainage system, but drainage outlets are not readily available in some areas. Soil blowing can be controlled by cover crops, such as rye, or by windbreaks. Because of the low landscape position, frost can damage crops.

This soil is fairly well suited to grasses and legumes for hay or pasture. The best suited forage species are those that can withstand wet conditions. These species include reed canarygrass and Garrison creeping foxtail. Overgrazing or grazing when the soil is wet causes compaction and deterioration of the pasture. Proper stocking rates, an adequate drainage system, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the wetness. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting equipment should be used only when the ground is frozen. The equipment can easily become bogged down in the organic material. Because of the wetness, the seedling mortality rate is high. It can be reduced by selecting water-tolerant species for planting. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

This soil is well suited to wetland wildlife habitat. It provides good habitat for waterfowl, furbearers, and big and small game. Developing areas of open water improves the habitat.

The land capability classification is IVw in drained areas, VIw in undrained areas. The woodland ordination symbol is 4W.

543—Markey muck. This nearly level, very poorly drained soil is in depressions on till plains, outwash plains, and moraines. It is subject to ponding. Areas are circular or oblong and range from 3 to 60 acres in size.

Typically, the upper 38 inches is black, very dark brown, and very dark gray muck. The underlying material to a depth of about 60 inches is dark gray and very dark gray, mottled sand. In places a dark mineral layer is beneath the organic material.

Included with this soil in mapping are Seelyeville soils, which make up 5 to 15 percent of the unit. These soils are in landscape positions similar to the Markey soil. They are organic to a depth of more than 51 inches.

Air and water move through the organic part of the Markey soil at a moderately rapid rate and through the underlying material at a rapid rate. The available water capacity is high or very high. Surface runoff is very slow or ponded in cultivated areas. The seasonal high water table is 1 foot above to 1 foot below the surface. The content of organic matter is very high, and natural fertility is low. The potential for frost action is high.

Most areas are used as unimproved pasture or as wildlife habitat. This soil is poorly suited to most of the crops commonly grown in the county. The wetness, the low fertility, and the hazard of soil blowing are the main management concerns. Open ditches and a subsurface drainage system that includes surface inlets can remove excess water and thus permit earlier planting and minimize the crop damage caused by ponding, but drainage outlets are not readily available in some areas.

This soil is fairly well suited to grasses and legumes for hay or pasture. It is best suited to the forage species that can withstand wet conditions. These species include reed canarygrass and Garrison creeping foxtail. Overgrazing or grazing when the soil is wet causes compaction and deterioration of the pasture. Proper stocking rates, an adequate drainage system, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the wetness. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting equipment should be used only when the ground is frozen. The equipment can easily become bogged down in the organic material. Because of the wetness, the seedling mortality rate is high. It can be reduced by selecting water-tolerant species for planting. The wetness during the planting season limits reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

This soil is well suited to wetland wildlife habitat. It provides good habitat for waterfowl, furbearers, and big and small game. Developing areas of open water improves the habitat.

The land capability classification is IVw in drained areas, VIw in undrained areas. The woodland ordination symbol is 4W.

544—Cathro muck. This nearly level, very poorly drained soil is in depressions on moraines and till plains. It is subject to ponding. Areas are circular or oblong and range from 5 to 60 acres in size.

Typically, the upper 30 inches is black and very dark grayish brown muck. The underlying material to a depth of about 60 inches is dark gray, mottled sandy loam. In some areas the muck is less than 16 or more than 50 inches thick.

Included with this soil in mapping are Flom, Runeberg, and Seelyeville soils, which make up 5 to 15 percent of the unit. These soils are in positions on the landscape similar to those of the Cathro soil. Flom and Runeberg soils are loamy throughout. Seelyeville soils are muck to a depth of more than 51 inches.

Air and water move through the organic part of the Cathro soil at a moderately slow to moderately rapid rate and through the underlying material at a moderately slow or moderate rate. The available water capacity is very high. Surface runoff is very slow or ponded. The seasonal high water table is 1 foot above to 1 foot below the surface. Organic matter content is very high. Natural fertility is low. The potential for frost action is high.

Most areas are used as unimproved pasture or as wildlife habitat. This soil is poorly suited to most of the crops commonly grown in the county. The wetness, the low fertility, and the hazard of soil blowing are the main management concerns. Open ditches and a subsurface drainage system that includes surface inlets can remove excess water and thus permit earlier planting and minimize the crop damage caused by ponding, but drainage outlets are not readily available in some areas.

This soil is fairly well suited to grasses and legumes for hay or pasture. The best suited forage species are those that can withstand wet conditions. Examples are reed canarygrass and Garrison creeping foxtail. Overgrazing or grazing when the soil is wet results in the formation of hummocks and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of fertilizer, restricted use during wet periods, and an adequate drainage system help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the wetness. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting equipment should be used only when the ground is frozen. The equipment can easily become bogged down in the organic material. Because of the wetness, the seedling mortality rate is high. It can be reduced by selecting water-tolerant species for planting. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

This soil is well suited to wetland wildlife habitat. It provides good habitat for waterfowl, furbearers, and big and small game. Developing areas of open water improves the habitat.

The land capability classification is IVw in drained areas, VIw in undrained areas. The woodland ordination symbol is 4W.

545—Rondeau muck. This nearly level, very poorly drained soil is in depressions on outwash plains and moraines. It is subject to ponding. Areas are irregular in shape and range from 5 to 80 acres in size.

Typically, the upper 30 inches is black and very dark brown muck. The underlying material to a depth of about 60 inches is dark grayish brown and gray coprogenous earth.

Included with this soil in mapping are Seelyeville soils, which make up 5 to 10 percent of the unit. These soils are in landscape positions similar to those of the Rondeau soil. They are muck to a depth of more than 51 inches.

Air and water move through the Rondeau soil at a slow or very slow rate. The available water capacity is very high. Runoff is ponded. The seasonal high water table is 1 foot above to 1 foot below the surface. Organic matter content is very high, and natural fertility is low. The potential for frost action is high.

Most areas are used as unimproved pasture or as wildlife habitat. This soil is fairly well suited to most of the crops commonly grown in the county. The wetness, the low fertility, and the hazard of soil blowing are the main management concerns. Open ditches and a subsurface drainage system that includes surface inlets can remove excess water, but drainage outlets are not readily available in some areas.

This soil is fairly well suited to grasses and legumes for hay or pasture. The best suited forage species are those that can withstand wet conditions. These species include reed canarygrass and Garrison creeping foxtail. Overgrazing or grazing when the soil is wet causes the formation of hummocks and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of fertilizer, restricted use during wet periods, and an adequate drainage system help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to wetland wildlife habitat. It provides good habitat for waterfowl, furbearers, and big and small game. Developing areas of open water improves the habitat.

The land capability classification is IIIw in drained areas, VIw in undrained areas. No woodland ordination symbol is assigned.

565—Eckvoll loamy sand. This nearly level and gently sloping, moderately well drained soil is on rises on sand-mantled till plains. Areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is black loamy sand about 9 inches thick. The subsurface layer is sand about 18 inches thick. The upper part is brown, and the lower part is dark brown. The subsoil is yellowish brown, mottled loam about 12 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some areas the sandy mantle is less than 20 or more than 40 inches thick. In areas east of Staples, the subsoil and underlying material have a higher content of silt.

Included with this soil in mapping are Blomford, Braham, Meehan, and Roscommon soils, which make up 5 to 15 percent of the unit. The poorly drained Blomford soils are in the lower landscape positions. The well drained Braham soils are on slight rises. The somewhat poorly drained Meehan soils are in shallow swales and on broad flats. They are sandy throughout. The poorly drained and very poorly drained Roscommon soils are in depressions.

Air and water move through the sandy part of the Eckvoll soil at a moderately rapid rate and through the subsoil and underlying material at a moderate rate. The available water capacity is moderate. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 2 to 5 feet. Organic matter content is moderately low or moderate, and natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland. A few are wooded. This soil is fairly well suited to most of the crops commonly grown in the county. Measures that reduce droughtiness, control erosion, and improve fertility are the main management needs. Applying a system of conservation tillage, returning crop residue to the soil, and including grasses and legumes in the cropping sequence are effective in conserving moisture and controlling erosion. Adding lime improves crop production.

This soil is well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, big bluestem, and indiangrass. Drought is a hazard. Water erosion in the steeper areas and soil blowing in all areas are other hazards. Overgrazing results in erosion, soil blowing, and deterioration of the pasture. Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer and lime, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIIs. The woodland ordination symbol is 3A.

571—Coriff sandy loam. This nearly level, poorly drained, calcareous soil is on broad flats and in swales on ground moraines. Areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is black sandy loam about 12 inches thick. The subsurface layer is very dark gray, calcareous sandy loam about 7 inches thick. The subsoil is about 16 inches thick. The upper part is grayish brown, mottled, calcareous loamy sand, and the lower part is olive gray, mottled, calcareous sandy loam. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some areas the soil has no lime in the upper 20 inches and is more than 40 inches deep to the underlying material. In other areas the subsoil has more gravel. In places the soil has an accumulation of lime in the upper 16 inches.

Included with this soil in mapping are small areas of the poorly drained Roliss soils, which make up 5 to 15 percent of the unit. These soils are in landscape positions similar to those of the Coriff soil. They do not have a stratified subsoil.

Air and water move through the upper part of the Coriff soil at a moderately rapid rate and through the lower part at a moderate rate. The available water capacity is high. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 1 to 3 feet. The content of organic matter and natural fertility are high. The potential for frost action also is high.

Most areas are used as cropland. If drained, this soil is well suited to most of the crops commonly grown in the county. Measures that reduce wetness and improve fertility are the main management needs. Open ditches and subsurface drainage lines can remove excess water if suitable outlets are available. Applications of fertilizer and manure help to maintain or improve fertility. Some crops are affected by the high content of lime in this soil. The crop varieties selected for planting should be those that are tolerant of lime.

If drained, this soil is well suited to red clover, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet results in surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of the wetness and the high content of lime. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw. No woodland ordination symbol is assigned.

572—Lowlein sandy loam. This nearly level, moderately well drained soil is on broad flats and on rises and ridges on ground moraines. Areas vary in shape and range from 3 to 40 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is about 16 inches thick. It is stratified. The upper part is dark yellowish brown loamy sand, and the lower part is dark yellowish brown, mottled sandy loam. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the stratified mantle is more than 40 inches thick. In other areas the subsoil has more gravel.

Included with this soil in mapping are small areas of Normania and Coriff soils, which make up 5 to 10 percent of the unit. The moderately well drained Normania soils are in landscape positions similar to those of the Lowlein soil. They are not stratified in the upper part. The poorly drained Coriff soils are in swales and depressions.

Air and water move through the upper part of the Lowlein soil at a moderately rapid or rapid rate and through the underlying material at a moderate rate. The available water capacity is moderate or high. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 2.5 to 5.0 feet. The content of organic matter and natural fertility are high. The potential for frost action is moderate.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. Applying a system of conservation tillage, applying manure, and returning crop residue to the soil improve fertility and tilth and conserve moisture.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is I. No woodland ordination symbol is assigned.

582—Roliss loam. This nearly level, poorly drained, calcareous soil is on broad flats and near the rims of depressions on till plains and ground moraines. Areas vary in shape and range from 5 to 80 acres in size.

Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsurface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 8 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled, calcareous loam. In some areas the surface soil and subsoil have no carbonates.

Included with this soil in mapping are areas of Normania soils, which make up 2 to 10 percent of the unit. These soils are moderately well drained and are on small rises. Also included are small areas of organic soils in depressions.

Air and water move through the Roliss soil at a moderate or moderately slow rate. The available water capacity is high. Surface runoff is very slow in cultivated areas. The seasonal high water table is at a depth of 1 to 3 feet. Organic matter content and natural fertility are high. The potential for frost action also is high, and the shrink-swell potential is moderate.

Most areas are used as cropland. If drained, this soil is well suited to most of the crops commonly grown in the county. The main management needs are measures that reduce wetness and improve fertility. Open ditches and subsurface drainage systems can remove excess water if suitable outlets are available. Applying fertilizer and manure or returning crop residue to the soil improves fertility. Some crops are affected by the high content of lime in this soil. The crop varieties selected for planting should be those that are tolerant of lime.

If drained, this soil is well suited to birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet results in surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of the wetness and the high content of lime. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw. No woodland ordination symbol is assigned.

701—Runeberg sandy loam, depressional. This nearly level, very poorly drained soil is in shallow depressions and sluggish drainageways in areas between drumlins and on ground moraines. It is subject to ponding. Areas are elongated or irregularly shaped and range from 3 to 100 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsoil is dark grayish brown and grayish brown, mottled sandy loam about 16 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous sandy loam. In some areas the soil has as much as 16 inches of muck on the surface. In other areas the subsoil has pockets or lenses of sand and gravel.

Included with this soil in mapping are small areas of Cathro, Paddock, Seelyeville, and Tacoosh soils, which make up 5 to 15 percent of the unit. The very poorly drained, organic Cathro, Seelyeville, and Tacoosh soils are in the lower areas and in drainageways and depressions. The somewhat poorly drained Paddock soils are on rises and in the more sloping areas.

Air and water move through the Runeberg soil at a moderately slow or slow rate. The available water capacity is moderate. Surface runoff is very slow or ponded in cultivated areas. The seasonal high water table is 1 foot above to 1 foot below the surface. Natural fertility is medium, and organic matter content is high. The potential for frost action also is high.

Most areas are used as pasture or cropland (fig. 9). This soil is fairly well suited to most of the crops commonly grown in the county. The wetness and the ponding are the major management concerns. They can be controlled by a drainage system if outlets are available. Surface stones interfere with cultivation in some areas. Rock picking may be needed to remove the stones from the fields.

This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. The best suited species are those that can withstand wet conditions. The major concerns in managing the pastured areas are overgrazing and grazing when the soil is wet. A drainage system, proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the wetness. The use of equipment is limited during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting equipment should be used only when the ground is frozen. Because of the wetness, the seedling mortality rate is moderate. It can be reduced by selecting suitable species for planting. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow.

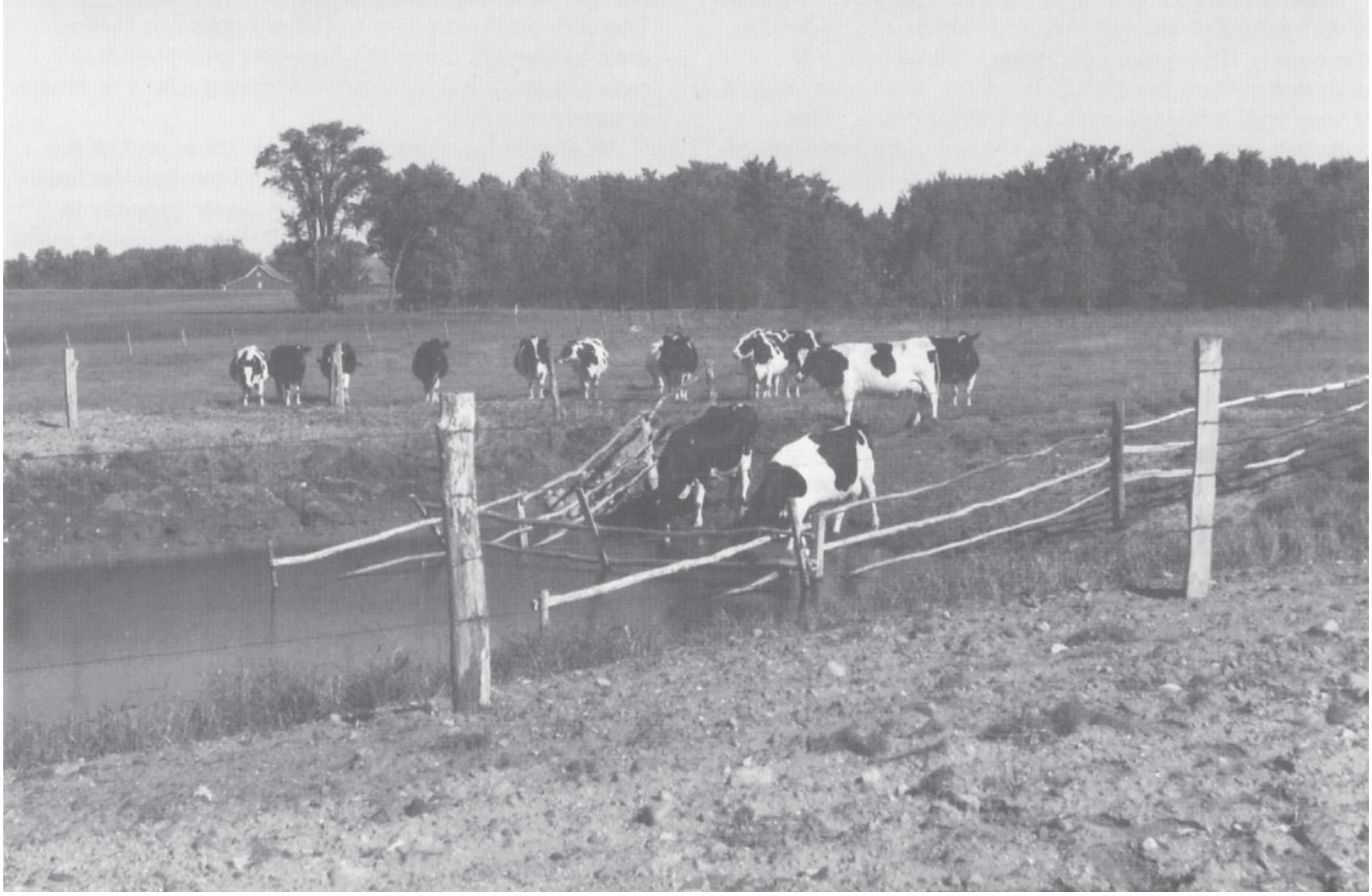

Figure 9.—A livestock watering facility in a pastured area of Runeberg sandy loam, depressional.

The land capability classification is IIIw. The woodland ordination symbol is 3W.

703—Paddock sandy loam. This nearly level, somewhat poorly drained soil is on slightly concave toe slopes and at the head of shallow drainageways on drumlins and ground moraines. Areas are elongated or irregularly shaped and range from 3 to 30 acres in size.

Typically, the surface layer is very dark brown sandy loam about 9 inches thick. The subsurface layer is dark grayish brown, mottled sandy loam about 6 inches thick. The next layer is grayish brown, mottled sandy loam about 7 inches thick. The subsoil is dark yellowish brown and dark grayish brown, mottled sandy loam about 21 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous, dense till that crushes to sandy loam. In some areas the subsoil is more friable and has more clay. In other areas the slope is more than 2 percent.

Included with this soil in mapping are small areas of Blowers and Runeberg soils, which make up 5 to 10 percent of the unit. The moderately well drained Blowers soils are in the higher or more sloping areas. The very poorly drained Runeberg soils are in depressions and low areas between drumlins. Also included are areas where the till has pockets or lenses of sandy material.

Air and water move through the upper part of the Paddock soil at a moderate rate and through the lower part at a very slow rate. The available water capacity is moderate. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 1 to 3 feet. Organic matter content is moderate, and natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland or pasture. This soil is well suited to most of the crops commonly grown in the county. The major limitation is the wetness. A drainage system is needed. If the soil is worked when it is very wet, it becomes cloddy and hard as it dries. Returning crop residue to the soil and applying manure help to maintain tilth. Surface stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

This soil is well suited to red clover, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of the trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIw. The woodland ordination symbol is 4W.

720B—Blowers sandy loam, 1 to 5 percent slopes. This nearly level and gently sloping, moderately well drained soil is on slightly concave or slightly convex side slopes and summits on drumlins and ground moraines. Areas are elongated or irregularly shaped and range from 5 to 100 acres in size.

Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The subsurface layer is dark grayish brown and yellowish brown sandy loam about 21 inches thick. The subsoil is sandy loam about 23 inches thick. The upper part is yellowish brown and grayish brown and is mottled, the next part is yellowish brown and mottled, and the lower part is yellowish brown. The underlying material to a depth of about 60 inches is yellowish brown, calcareous, dense till that crushes to sandy loam. In some areas the subsoil has a higher content of clay. In other areas the surface layer is thicker. In some small areas the slope is less than 1 or more than 5 percent.

Included with this soil in mapping are small areas of Paddock, Rockwood, and Runeberg soils, which make up about 5 to 10 percent of the unit. The somewhat poorly drained Paddock soils are at the base of slopes and at the head of shallow drainageways. The well drained Rockwood soils are in the more sloping areas. The very poorly drained Runeberg soils are in the drainageways and valleys between drumlins. Also included are areas where the till has pockets or lenses of sandy material.

Air and water move through the upper part of the Blowers soil at a moderate rate and through the lower part at a slow rate. The available water capacity is moderate. Surface runoff is medium in cultivated areas. A perched seasonal high water table is at a depth of 2 to 3 feet. Organic matter content is moderate, and natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. Water erosion is the main hazard. Applying a system of conservation tillage, returning crop residue to the soil, and applying manure are effective in controlling erosion, minimizing crusting, improving fertility, and increasing the rate of water infiltration. Timely fieldwork is necessary. If it is used during wet periods, equipment can get stuck in this soft soil. Because of the number of surface stones, rock picking is common.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of lime and fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IIe. The woodland ordination symbol is 4A.

800B—Kandota-Dorset sandy loams, 2 to 6 percent slopes. These gently sloping, well drained soils are on convex or concave side slopes, head slopes, and summits on ground moraines, outwash plains, and uplands. Areas are irregular in shape and range from 5 to 80 acres in size. They are about 50 percent Kandota soil and 40 percent Dorset soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Kandota soil has a surface layer of very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is grayish brown sandy loam about 4 inches thick. The subsoil is sandy loam about 17 inches thick. The upper part is grayish brown and dark yellowish brown, and the lower part is yellowish brown. The underlying material to a depth of about 60 inches is light olive brown, calcareous sandy loam. In some small areas the slope is less than 2 or more than 6 percent.

Typically, the Dorset soil has a surface layer of very dark brown sandy loam about 8 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam, and the lower part is yellowish brown gravelly sand and sand. The underlying material to a depth of about 60 inches is pale brown, calcareous gravelly sand and sand. In some areas on the crest of the slopes, the soil has a coarser textured surface layer and subsurface layer and is shallower to the calcareous underlying material. In some small areas the slope is less than 2 or more than 6 percent.

Included with these soils in mapping are small areas of Forada, Runeberg, and Wykeham soils, which make up about 10 percent of the unit. The moderately well drained Wykeham soils are on concave head slopes and in sloping drainageways. The poorly drained Runeberg and Forada soils are in drainageways and depressions.

Air and water move through the Kandota soil at a moderately slow rate. They move through the upper part of the Dorset soil at a moderately rapid rate and through the lower part at a rapid rate. The available water capacity is moderate in the Kandota soil and low in the Dorset soil. In cultivated areas surface runoff is medium on the Kandota soil and slow on the Dorset soil. Organic matter content is moderate in both soils. Natural fertility is medium in the Kandota soil and low in the Dorset soil. The potential for frost action is moderate in the Kandota soil.

Most areas are used as cropland. Some are used as pasture. These soils are well suited to most of the crops commonly grown in the county. The hazards of water erosion and drought are the main management concerns. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soil, applying manure, and including grasses and legumes in the cropping sequence are effective in controlling erosion, improving tilth and fertility, and conserving moisture. In some areas grassed waterways are needed to prevent gullying.

These soils are well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soils are wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer and lime, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited or poorly suited to woodland. Productivity is moderate or moderately high. Droughtiness results in a moderate rate of seedling mortality on the Dorset soil. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification of the Kandota soil is IIe, and that of the Dorset soil is IIIe. The woodland ordination symbol assigned to the Kandota soil is 4A, and that assigned to the Dorset soil is 2S.

800C—Kandota-Dorset sandy loams, 6 to 15 percent slopes. These rolling and hilly, well drained soils are on complex side slopes and summits on ground moraines, outwash plains, and uplands. Areas are irregular in shape and range from 10 to 150 acres in size. They are about 50 percent Kandota soil and 40 percent Dorset soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Kandota soil has a surface layer of very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is grayish brown sandy loam about 8 inches thick. The subsoil is sandy loam about 14 inches thick. The upper part is grayish brown and dark yellowish brown, and the lower part is yellowish brown. The underlying material to a depth of about 60 inches is light olive brown, calcareous sandy loam. In some small areas the slope is less than 6 or more than 15 percent.

Typically, the Dorset soil has a surface layer of very dark brown sandy loam about 8 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam, and the lower part is yellowish brown gravelly sand and sand. The underlying material to a depth of about 60 inches is pale brown, calcareous gravelly coarse sand. In some areas on the crest of the slopes, the soil has a coarser textured surface layer and subsoil and is shallower to the calcareous underlying material. In some small areas the slope is less than 6 or more than 15 percent.

Included with these soils in mapping are small areas of Forada, Runeberg, and Wykeham soils, which make up about 10 percent of the unit. The moderately well drained Wykeham soils are on concave head slopes and in sloping drainageways. The poorly drained Forada and Runeberg soils are in drainageways and depressions.

Air and water move through the Kandota soil at a moderately slow rate. They move through the upper part of the Dorset soil at a moderately rapid rate and through the lower part at a rapid rate. The available water capacity is moderate in the Kandota soil and low in the Dorset soil. In cultivated areas surface runoff is medium or rapid on the Kandota soil and medium on the Dorset soil. Organic matter content is moderate in both soils. Natural fertility is medium in the Kandota soil and low in the Dorset soil. The potential for frost action is moderate in the Kandota soil.

Most areas are used as woodland or pasture. These soils are poorly suited to cropland. The hazard of water erosion on both soils and droughtiness in the Dorset soil are the main management concerns. Terraces and diversions, contour farming, stripcropping, and cover crops help to control erosion and runoff. Returning crop residue to the soil or applying manure improves fertility, minimizes crusting, and increases the rate of water infiltration.

These soils are well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, and orchardgrass. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soils are wet results in surface compaction, excessive runoff, poor tilth, and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited or poorly suited to woodland. Productivity is moderately high or moderate. Droughtiness results in a moderate rate of seedling mortality on the Dorset soil. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is IVe. The woodland ordination symbol assigned to the Kandota soil is 4A, and that assigned to the Dorset soil is 2S.

800E—Kandota-Dorset sandy loams, 15 to 40 percent slopes. These hilly and steep, well drained soils are on complex side slopes and summits on ground moraines, outwash plains, and uplands. Areas are irregular in shape and range from 10 to 150 acres in size. They are about 50 percent Kandota soil and 40 percent Dorset soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Kandota soil has a surface layer of very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is dark grayish brown sandy loam about 8 inches thick. The subsoil is sandy loam about 17 inches thick. The upper part is grayish brown and dark yellowish brown, and the lower part is yellowish brown. The underlying material to a depth of about 60 inches is yellowish brown, calcareous sandy loam. In some small areas the slope is less than 15 or more than 40 percent.

Typically, the Dorset soil has a surface layer of very dark brown sandy loam about 8 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown sandy loam, and the lower part is yellowish brown gravelly sand and sand. The underlying material to a depth of about 60 inches is pale brown, calcareous gravelly coarse sand. In some areas the soil has a coarser textured surface layer and subsoil and is shallower to the calcareous underlying material. In some small areas on the crest of the slopes, the slope is less than 15 or more than 40 percent.

Included with these soils in mapping are small areas of Forada and Runeberg soils, which make up about 10 percent of the unit. These included soils are poorly drained and are in drainageways and depressions.

Air and water move through the Kandota soil at a moderately slow rate. They move through the upper part of the Dorset soil at a moderately rapid rate and through the lower part at a rapid rate. The available water capacity is moderate in the Kandota soil and low in the Dorset soil. Surface runoff is rapid on the Kandota soil and medium on the Dorset soil. Organic matter content is moderate in both soils. Natural fertility is medium in the Kandota soil and low in the Dorset soil. The potential for frost action is moderate in the Kandota soil.

Most areas are used for hay, pasture, or woodland. Because of the slope and the hazard of erosion, these soils are unsuitable as cropland. They are fairly well suited to grasses and legumes for hay or pasture. Suitable forage species include alfalfa, birdsfoot trefoil, smooth bromegrass, switchgrass, and big bluestem. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soils are wet results in surface compaction, excessive runoff, poor tilth, and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. The slope limits the effectiveness of the windbreaks. Water erosion is a severe hazard unless a plant cover protects the surface and site preparation is limited to the area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited or poorly suited to woodland. Productivity is moderately high or moderate. The main limitation is the slope. Erosion is a hazard on logging roads and skid trails. It can be controlled by building the roads and trails on the contour. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. Droughtiness results in a moderate rate of seedling mortality on the Dorset soil. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification is VIe. The woodland ordination symbol assigned to the Kandota soil is 4R, and that assigned to the Dorset soil is 2R.

808—Wykeham-Runeberg sandy loams. These nearly level soils are on ground and end moraines. The moderately well drained Wykeham soil is in slightly convex areas. The poorly drained Runeberg soil is in swales and drainageways. Areas are irregular in shape and range from 5 to 100 acres in size. They are about 45 to 55 percent Wykeham soil and 35 to 45 percent Runeberg soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Wykeham soil has a surface layer of very dark grayish brown sandy loam about 8 inches thick. The subsurface layer is grayish brown sandy loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown and yellowish brown sandy loam, and the lower part is yellowish brown and light olive brown, mottled sandy clay loam. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous sandy loam.

Typically, the Runeberg soil has a surface layer of black sandy loam about 9 inches thick. The subsurface layer is very dark gray sandy loam about 3 inches thick. The subsoil is grayish brown, mottled sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light olive brown, mottled, calcareous sandy loam. In some small areas the soil has a slope of more than 2 percent or is depressional.

Included with these soils in mapping are small areas of the well drained Kandota soils, which make up 5 to 10 percent of the unit. These included soils are on convex slopes.

Air and water move through the Wykeham and Runeburg soils at a moderately slow rate. The available water capacity is high. Surface runoff is slow in cultivated areas. The water table is at a depth of 2.5 to 5.0 feet in the Wykeham soil and 0.5 foot to 2.0 feet in the Runeberg soil. Organic matter content is moderate in the Wykeham soil and high in the Runeberg soil. Natural fertility is medium in both soils. The potential for frost action is moderate in the Wykeham soil and high in the Runeberg soil.

Most areas are used as cropland. Some are used as pasture. These soils are well suited to most of the crops commonly grown in the county. The major limitation is the wetness. A drainage system is needed. Returning crop residue to the soils and applying manure help to maintain good tilth, improve fertility, and minimize crusting.

If drained, these soils are well suited to red clover, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soils are wet results in surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils.

Cultivation or applications of herbicide help to remove competing vegetation.

The Wykeham soil is fairly well suited to woodland, but the Runeberg soil is poorly suited. Productivity is moderately high on the Wykeham soil and moderate on the Runeburg soil. The main limitation is the wetness of the Runeberg soil. The use of equipment is limited during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting equipment should be used only when the ground is frozen. Because of the wetness, the seedling mortality rate is moderate. It can be reduced by selecting suitable species for planting. The wetness hinders planting and thus restricts reforestation. Trees on the Runeberg soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification of the Wykeham soil is IIe, and that of the Runeberg soil is IIw. The woodland ordination symbol assigned to the Wykeham soil is 4A, and that assigned to the Runeberg soil is 3W.

823—Hangaard-Sioux complex. These nearly level and gently sloping soils are in concave or convex areas on beach ridges along the edges of lakes, former lakes, and ponds. The Hangaard soil is poorly drained, and the Sioux soil is excessively drained. Areas are long and narrow or are irregularly shaped. They range from 5 to 35 acres in size. They are about 60 percent Hangaard soil and 30 percent Sioux soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Hangaard soil has a surface layer of black sandy loam about 9 inches thick. The subsoil is very dark grayish brown loamy sand about 5 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown and grayish brown, mottled, calcareous gravelly sand. In places it has more clay and more silt. In some small areas the slope is more than 5 percent.

Typically, the Sioux soil has a surface layer of black loamy sand about 7 inches thick. The subsurface layer is dark brown sand about 5 inches thick. The underlying material to a depth of about 60 inches is brown and pale brown, calcareous gravelly sand. In some areas the soil has more sand and has no coarse fragments. In a few areas large boulders have been pushed up into the ridges by ice action along the edges of the lakes. In places the soil has loamy till in the lower part of the underlying material. In some small areas the slope is more than 5 percent.

Included with these soils in mapping are small areas of Markey and Osakis soils, which make up about 10 percent of the unit. The very poorly drained, organic Markey soils are in swales. The moderately well drained Osakis soils are on slight rises above the Hangaard soil and below the Sioux soil. Also included are small ponded areas that support marsh vegetation.

Air and water move through the Hangaard soil at a rapid rate. They move through the upper part of the Sioux soil at a rapid rate and through the underlying material at a rapid or very rapid rate. The available water capacity is low in both soils. Surface runoff is slow in cultivated areas. The Hangaard soil has a seasonal high water table at a depth of 1 to 3 feet. Organic matter content is moderate or high in the Hangaard soil and moderately low in the Sioux soil. Natural fertility is medium or high in the Hangaard soil and low in the Sioux soil. The potential for frost action is moderate in the Hangaard soil.

Most areas are developed for recreational uses or are pastured. Because of the wetness of the Hangaard soil and the hazard of drought in the Sioux soil, these soils are poorly suited to most of the crops commonly grown in the county. They are fairly well suited to grasses and legumes for hay or pasture. Overgrazing results in deterioration of the pasture. Proper stocking rates, pasture rotation, applications of fertilizer and lime, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on the Hangaard soil should be those that are tolerant of wetness. The ones grown on the Sioux soil should be those that are tolerant of droughty conditions.

The land capability classification of the Hangaard soil is IVw, and that of the Sioux soil is VIs. No woodland ordination symbol is assigned to either soil.

824C—Dorset-Sioux sandy loams, 6 to 15 percent slopes. These rolling and hilly soils are on complex side slopes and summits on outwash plains and moraines. The Dorset soil is well drained, and the Sioux soil is excessively drained. Areas are irregular in shape and range from 5 to 100 acres in size. They are about 45 to 55 percent Dorset soil and 35 to 45 percent Sioux soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Dorset soil has a surface layer of very dark brown sandy loam about 6 inches thick. The subsoil is about 15 inches of dark yellowish brown gravelly sandy loam and gravelly loamy sand. The underlying material to a depth of about 60 inches is yellowish brown, pale brown, and very pale brown, calcareous gravelly coarse sand. In some areas, the surface layer is thicker and darker and the subsoil contains more silt and more clay. In some small areas the slope is less than 6 or more than 15 percent.

Typically, the Sioux soil has a surface layer of black sandy loam about 6 inches thick. The next 14 inches is dark brown gravelly sand and dark yellowish brown gravelly loamy sand. The underlying material to a depth of about 60 inches is light gray to yellowish brown, calcareous gravelly coarse sand. In some areas the soil has more clay directly below the surface layer and is leached to a greater depth. In other areas the lower part of the underlying material has more clay and more silt. In some small areas the slope is less than 6 or more than 15 percent.

Included with these soils in mapping are small areas of Forada, Hangaard, Markey, and Osakis soils, which make up about 5 to 15 percent of the unit. The poorly drained Forada and Hangaard soils are in depressions and drainageways. The very poorly drained, organic Markey soils are in deep depressions. The moderately well drained Osakis soils are in nearly level areas characterized by little relief.

Air and water move through the upper part of the Dorset soil at a moderately rapid rate and through the lower part at a rapid rate. They move through the upper part of the Sioux soil at a rapid rate and through the lower part at a very rapid rate. The available water capacity is low in both soils. Surface runoff is slow in cultivated areas. Organic matter content is moderate in the Dorset soil and moderately low in the Sioux soil. Natural fertility is low in both soils.

Most areas are used as cropland or pasture. These soils are poorly suited to cultivated crops because of the hazards of water erosion and drought. Applying a system of conservation tillage, farming on the contour, applying fertilizer, and growing cover crops help to control erosion, increase the organic matter content, and conserve moisture. Early maturing crops, such as small grain, can make the best use of the soil moisture available in the spring.

These soils are well suited to many forage grasses and legumes, including alfalfa, smooth bromegrass, and orchardgrass. A cover of these plants is effective in controlling erosion. Overgrazing or grazing when the soils are wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The Dorset soil is poorly suited to woodland. Productivity is moderate. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Commercial trees do not grow naturally on the Sioux soil, which originally supported native grasses.

The land capability classification of the Dorset soil is IVe, and that of the Sioux soil is VIs. The woodland ordination symbol assigned to the Dorset soil is 2S. No woodland ordination symbol is assigned to the Sioux soil.

824E—Dorset-Sioux complex, 15 to 30 percent slopes. These hilly to very steep soils are on complex slopes on the sides and summits of ground moraines and on outwash plains. Areas are irregular in shape and range from 5 to 150 acres in size. They are about 50 percent Dorset soil and 35 percent Sioux soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Dorset soil has a surface layer of black sandy loam about 8 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown sandy loam. The lower part is dark brown and very dark grayish brown gravelly loamy coarse sand and gravelly sand. The underlying material to a depth of about 60 inches is stratified dark brown sand and brown and pale brown, calcareous gravelly sand. In places the surface layer is thinner and lighter colored. In some small areas the slope is less than 15 or more than 30 percent.

Typically, the Sioux soil has a surface layer of very dark brown loamy sand about 5 inches thick. The next 15 inches is dark yellowish brown and yellowish brown gravelly loamy sand. The underlying material to a depth of about 60 inches is yellowish brown to light gray, calcareous gravelly coarse sand. In some areas free carbonates are directly below the surface layer. In other areas the soil has more sand throughout and has no coarse fragments in the upper part. In some small areas the slope is less than 15 or more than 30 percent.

Included with these soils in mapping are small areas of Hangaard and Markey soils, which make up about 15 percent of the unit. The poorly drained Hangaard soils are in depressions and drainageways. The very poorly drained Markey soils are in pockets and deep depressions. They are organic in the upper part.

Air and water move through the upper part of the Dorset soil at a moderately rapid rate and through the lower part at a rapid rate. They move through the upper part of the Sioux soil at a rapid rate and through the lower part at a very rapid rate. The available water capacity is low in both soils. Surface runoff is slow. Organic matter content is moderate in the Dorset soil and moderately low in the Sioux soil. Natural fertility is low in both soils.

Most areas are used for pasture or wildlife habitat. Some are used for hay or woodland. Because of the slope and the hazard of erosion, these soils are unsuitable as cropland. They are well suited to many forage grasses and legumes, including alfalfa, little bluestem, sideoats grama, intermediate wheatgrass, smooth bromegrass, and orchardgrass. A cover of these plants is effective in controlling erosion. Overgrazing or grazing when the soils are wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. The slope limits the effectiveness of the windbreaks. Water erosion is a severe hazard unless a plant cover protects the surface and site preparation is limited to the area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

The Dorset soil is poorly suited to woodland. Productivity is moderate. The main limitation is the slope. Erosion is a hazard on logging roads and skid trails. It can be controlled by building the roads and trails on the contour. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. The droughtiness causes a high rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Commercial trees do not grow naturally on the Sioux soil, which originally supported native grasses.

The land capability classification is VIe. The woodland ordination symbol assigned to the Dorset soil is 2R. No woodland ordination symbol is assigned to the Sioux soil.

825—Gonvick-Flom loams. These nearly level soils are on slightly convex rises and in swales and drainageways on ground moraines. The moderately well drained Gonvick soil is on slight rises. The poorly drained Flom soil is in swales and drainageways. Areas are irregular in shape and range from 5 to 90 acres in size. They are about 60 percent Gonvick soil and 30 percent Flom soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Gonvick soil has a surface layer of black loam about 9 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil is loam about 12 inches thick. The upper part is olive brown, and the lower part is grayish brown and mottled. The underlying material to a depth of about 60 inches is grayish brown and light yellowish brown, mottled, calcareous loam. In places the soil is well drained.

Typically, the Flom soil has a surface layer of black loam about 15 inches thick. The subsoil is grayish brown, mottled loam about 15 inches thick. The underlying material to a depth of about 60 inches is light brownish gray, mottled, calcareous loam. In some areas the surface layer and subsoil are calcareous. In other areas they have a higher content of sand. In some small areas the slope is more than 3 percent.

Included with these soils in mapping are small areas of the very poorly drained Bluffton soils and the very poorly drained, organic Cathro soils. Included soils make up about 10 percent of the unit. They are in depressions.

Air and water move through the Gonvick soil at a moderate rate and through the Flom soil at a moderately slow rate. The available water capacity is high in both soils. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 2.5 to 6.0 feet in the Gonvick soil and 1.0 to 3.0 feet in the Flom soil. Organic matter content is moderate in the Gonvick soil and high in the Flom soil. Natural fertility is high in both soils. The potential for frost action also is high, and the shrink-swell potential is moderate.

Most areas are used as cropland. Some are pastured. These soils are well suited to most of the crops commonly grown in the county. A drainage system needed to reduce the wetness of the Flom soil. Returning crop residue to the soils and applying manure help to maintain good tilth, improve fertility, and minimize crusting.

These soils are well suited to alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

The Gonvick soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping. Commercial trees do not grow naturally on the Flom soil, which originally supported native grasses.

The land capability classification of the Gonvick soil is I, and that of the Flom soil is IIw. The woodland ordination symbol assigned to the Gonvick soil is 4A. No woodland ordination symbol is assigned to the Flom soil.

873—Prebish-Nokay sandy loams. These nearly level soils are on glacial moraines. The poorly drained Prebish soil is in depressions. The somewhat poorly drained Nokay soil is on small rises, in the upper parts of drainageways, and on the rims of depressions. Areas are irregular in shape and range from 4 to 40 acres in size. They are about 45 percent Prebish soil and 35 percent Nokay soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Prebish soil has a surface layer of black and very dark grayish brown, mottled sandy loam about 14 inches thick. The subsurface layer is very dark gray, mottled sandy loam about 6 inches thick. The subsoil is gray and grayish brown, mottled sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sandy loam. In some places the surface layer is thicker or thinner. In other places it is organic and is as much as 6 inches thick. Some areas are ponded in the spring.

Typically, the Nokay soil has a surface layer of very dark gray sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, mottled sandy loam about 10 inches thick. The subsoil is mottled sandy loam about 23 inches thick. The upper part is grayish brown, and the lower part is dark brown. The underlying material to a depth of about 60 inches is dark brown, mottled, dense till that crushes to sandy loam. In places the surface layer is thicker. In some small areas the slope is more than 2 percent.

Included with these soils in mapping are small areas of Alstad, Cathro, and Tacoosh soils, which make up about 5 to 25 percent of the unit. The moderately well drained Alstad soils are on the higher flats and in the more undulating areas. The very poorly drained, organic Cathro and Tacoosh soils are in depressions. Also included are small areas of soils having a silty mantle that is 15 to 36 inches deep over loamy till.

Air and water move through the Prebish and Nokay soils at a moderately slow rate. The available water capacity is high. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 0.5 to 1.0 foot in the Prebish soil and 1.0 to 3.0 feet in the Nokay soil. Organic matter content is high in both soils. Natural fertility is low in the Prebish soil and medium in the Nokay soil. The potential for frost action is high in both soils.

Most areas support native vegetation, wild hay, or pasture plants. Some are used as cropland. Because of the wetness, these soils are poorly suited to most of the crops commonly grown in the county. A drainage system is needed. If worked when wet, the soils become cloddy and hard as they dry. Returning crop residue to the soils and applying manure help to maintain tilth.

These soils are fairly well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. The wetness is a major limitation. The best suited species are those that can withstand wet conditions. Overgrazing or grazing when the soils are wet causes compaction and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

The Nokay soil is fairly well suited to woodland, but the Prebish soil is poorly suited. Productivity is moderately high on the Nokay soil and moderate on the Prebish soil. The main limitation is the wetness. The use of equipment is limited during wet periods, when the soils are soft and cannot support heavy equipment.

Harvesting equipment should be used only when the ground is frozen. The wetness hinders planting and thus restricts reforestation. Because of the wetness, the seedling mortality rate is moderate. It can be reduced by selecting suitable species for planting. Trees on the Prebish soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

These soils are well suited to the development of wetland wildlife habitat. They are suitable for the construction of impoundments, which can flood the soils.

The land capability classification of the Prebish soil is IVw, and that of the Nokay soil is IIw. The woodland ordination symbol assigned to the Prebish soil is 3W, and that assigned to the Nokay soil is 4A.

928B—Cushing-DeMontreville-Mahtomedi complex, 2 to 8 percent slopes. These undulating soils are on complex side slopes and summits on ground and end moraines. The Cushing and DeMontreville soils are well drained, and the Mahtomedi soil is excessively drained. Areas are irregular in shape and range from 5 to about 500 acres in size. They are about 35 percent Cushing soil, 30 percent Mahtomedi soil, and 25 percent DeMontreville soil. The three soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Cushing soil has a surface layer of very dark gray sandy loam about 3 inches thick. The subsurface layer is dark brown sandy loam about 22 inches thick. The subsoil is dark brown sandy loam about 32 inches thick. The underlying material to a depth of about 60 inches is strong brown sandy loam. In places the subsoil and underlying material are finer textured or are more yellow. In some small areas the slope is less than 2 or more than 8 percent.

Typically, the DeMontreville soil has a surface layer of black loamy sand about 4 inches thick. The subsurface layer is dark grayish brown and dark brown loamy sand about 26 inches thick. The subsoil is dark brown sandy loam about 23 inches thick. The underlying material to a depth of about 60 inches also is dark brown sandy loam. In some small areas the slope is less than 2 or more than 8 percent.

Typically, the Mahtomedi soil has a surface layer of very dark grayish brown loamy sand about 8 inches thick. The subsurface layer is grayish brown sand about 4 inches thick. The subsoil is dark brown gravelly coarse sand about 18 inches thick. The underlying material to a depth of about 60 inches is dark brown sand and yellowish brown gravelly coarse sand. In places the soil has very few coarse fragments. In some small areas the slope is less than 2 or more than 8 percent.

Included with this soil in mapping are small areas of Alstad, Nokay, and Prebish soils, which make up about 10 percent of the unit. The moderately well drained Alstad soils are in the less sloping areas. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the upper part of the Cushing soil at a moderate rate and through the lower part at a moderately slow rate. They move through the upper part of the DeMontreville soil at a rapid rate and through the lower part at a moderately slow rate. They move through the Mahtomedi soil at a rapid rate. The available water capacity is moderate in the Cushing and DeMontreville soils and low in the Mahtomedi soil. Surface runoff is medium on all three soils. Organic matter content is moderately low in the Cushing soil and low in the DeMontreville and Mahtomedi soils. Natural fertility is medium in the Cushing soil and low in the DeMontreville and Mahtomedi soils. The potential for frost action is moderate in the Cushing soil.

Most areas are used as cropland or pasture. These soils are fairly well suited to most of the crops commonly grown in the county. The hazards of water erosion and drought are the main management concerns. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soils, applying manure, and including grasses and legumes in the cropping sequence are effective in controlling erosion, maintaining tilth and fertility, and conserving moisture. In places grassed waterways are needed to prevent gullying. Stones interfere with cultivation in some areas. Rock picking may be needed to remove the stones from the fields.

These soils are well suited to alfalfa, red clover, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soils are wet results in surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to woodland. Productivity is moderate or moderately high. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification of the Cushing soil is IIe, that of the DeMontreville soil is IIIs, and that of the Mahtomedi soil is IVs. The woodland ordination symbol assigned to the Cushing soil is 4A, that assigned to the DeMontreville soil is 4S, and that assigned to the Mahtomedi soil is 2S.

928C—Cushing-DeMontreville-Mahtomedi complex, 8 to 15 percent slopes. These rolling and hilly soils are on complex side slopes and summits on ground and end moraines. The Cushing and DeMontreville soils are well drained, and the Mahtomedi soil is excessively drained. Areas are irregular in shape and range from 5 to 50 acres in size. They are about 35 percent Cushing soil, 30 percent DeMontreville soil, and 25 percent Mahtomedi soil. The three soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Cushing soil has a surface layer of very dark brown sandy loam about 5 inches thick. The subsurface layer is dark grayish brown sandy loam about 14 inches thick. The subsoil is dark brown sandy loam about 23 inches thick. The underlying material to a depth of about 60 inches also is dark brown sandy loam. In places the subsoil and underlying material are finer textured or are more yellow. In some small areas the slope is less than 8 or more than 15 percent.

Typically, the DeMontreville soil has a surface layer of very dark brown loamy sand about 5 inches thick. The subsurface layer is dark grayish brown loamy sand about 16 inches thick. The subsoil is dark brown sandy loam about 23 inches thick. The underlying material to a depth of about 60 inches also is dark brown sandy loam. In some small areas the slope is less than 8 or more than 15 percent.

Typically, the Mahtomedi soil has a surface layer of very dark gray loamy sand about 4 inches thick. The subsurface layer is grayish brown sand about 4 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown gravelly coarse sand, and the lower part is strong brown coarse sand. The underlying material to a depth of about 60 inches is dark brown and brown gravelly sand. In some areas the soil has very few coarse fragments. In other areas the underlying material has free carbonates.

Included with these soils in mapping are small areas of Alstad, Nokay and Prebish soils, which make up about 10 percent of the unit. The moderately well drained Alstad soils are in the less sloping areas. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the upper part of the Cushing soil at a moderate rate and through the lower part at a moderately slow rate. They move through the upper part of the DeMontreville soil at a rapid rate and through the lower part at a moderately slow rate. They move through the Mahtomedi soil at a rapid rate. The available water capacity is moderate in the Cushing and DeMontreville soils and low in the Mahtomedi soil. Surface runoff is medium in cultivated areas of all three soils. Organic matter content is moderately low in the Cushing soil and low in the DeMontreville and Mahtomedi soils. Natural fertility is medium in the Cushing soil and low in the DeMontreville and Mahtomedi soils. The potential for frost action is moderate in the Cushing soil.

Most areas are used as cropland or pasture. These soils are poorly suited to most of the crops commonly grown in the county. The hazards of water erosion and drought are the main management concerns. Applying a system of conservation tillage, farming on the contour, returning crop residue to the soils, applying manure, and including grasses and legumes in the cropping sequence are effective in controlling erosion, maintaining tilth and fertility, and conserving moisture. In places grassed waterways are needed to prevent gullying. In some areas surface stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

These soils are well suited to many forage grasses and legumes. Suitable species include alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, and orchardgrass. A cover of these plants is effective in controlling water erosion. Overgrazing or grazing when the soils are wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to woodland. Productivity is moderate or moderately high. The main limitation is the droughtiness, which causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification of the Cushing soil is IIIe, that of the DeMontreville soil is IVe, and that of the Mahtomedi soil is IVs. The woodland ordination symbol assigned to the Cushing soil is 4A, that assigned to the DeMontreville soil is 4S, and that assigned to the Mahtomedi soil is 2S.

928E—Cushing-DeMontreville-Mahtomedi complex, 15 to 45 percent slopes. These hilly to very steep soils are on complex side slopes and ridges on ground and end moraines. The Cushing and DeMontreville soils are well drained, and the Mahtomedi soil is excessively drained. Areas are irregular in shape and range from 5 to 60 acres in size. They are about 35 percent Cushing soil, 30 percent DeMontreville soil, and 25 percent Mahtomedi soil. The three soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Cushing soil has a surface layer of very dark gray sandy loam about 3 inches thick. The subsurface layer is brown and dark brown sandy loam about 14 inches thick. The subsoil is dark brown sandy loam about 34 inches thick. The underlying material to a depth of about 60 inches also is dark brown sandy loam. In places the subsoil and underlying material are finer textured or are more yellow. In some small areas the slope is less than 15 or more than 45 percent.

Typically, the DeMontreville soil has a surface layer of very dark brown loamy sand about 3 inches thick. The subsurface layer is dark brown loamy sand about 20 inches thick. The subsoil is dark yellowish brown and dark brown sandy loam about 25 inches thick. The underlying material to a depth of about 60 inches is dark brown sandy loam. In some small areas the slope is less than 15 or more than 45 percent.

Typically, the Mahtomedi soil has a surface layer of very dark brown loamy sand about 5 inches thick. The subsurface layer is dark brown sand about 13 inches thick. The subsoil is dark brown and strong brown gravelly coarse sand about 12 inches thick. The underlying material to a depth of about 60 inches is dark brown and brown sand and gravelly coarse sand. In some areas the soil has very few coarse fragments. In other areas the underlying material has free carbonates.

Included with these soils in mapping are small areas of Alstad, Nokay, and Prebish soils, which make up about 10 percent of the unit. The moderately well drained Alstad soils are in the less sloping areas. The somewhat poorly drained Nokay and very poorly drained Prebish soils are in depressions and drainageways.

Air and water move through the upper part of the Cushing soil at a moderate rate and through the lower part at a moderately slow rate. They move through the upper part of the DeMontreville soil at a rapid rate and through the lower part at a moderately slow rate. They move through the Mahtomedi soil at a rapid rate. The available water capacity is moderate in the Cushing and DeMontreville soils and low in the Mahtomedi soil. Surface runoff is medium on all three soils. Organic matter content is moderately low in the Cushing soil and low in the DeMontreville and Mahtomedi soils. Natural fertility is low in all three soils. The potential for frost action is moderate in the Cushing soil.

Most areas are used as wooded pasture or as woodland. Many are used as wildlife habitat or are developed for recreational uses. Because of the slope and the hazards of water erosion and drought, these soils are unsuitable as cropland and pasture.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. The effectiveness of windbreaks is impaired by the slope. The hazard of water erosion is severe unless a plant cover protects the site. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to woodland. Productivity is moderate or moderately high. The main limitation is the slope. Erosion is a hazard on logging roads and skid trails. It can be controlled by building the roads and skid trails on the contour. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. The droughtiness of the DeMontreville and Mahtomedi soils causes a moderate rate of seedling mortality. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping.

The land capability classification of the Cushing and DeMontreville soils is VIIe, and that of the Mahtomedi

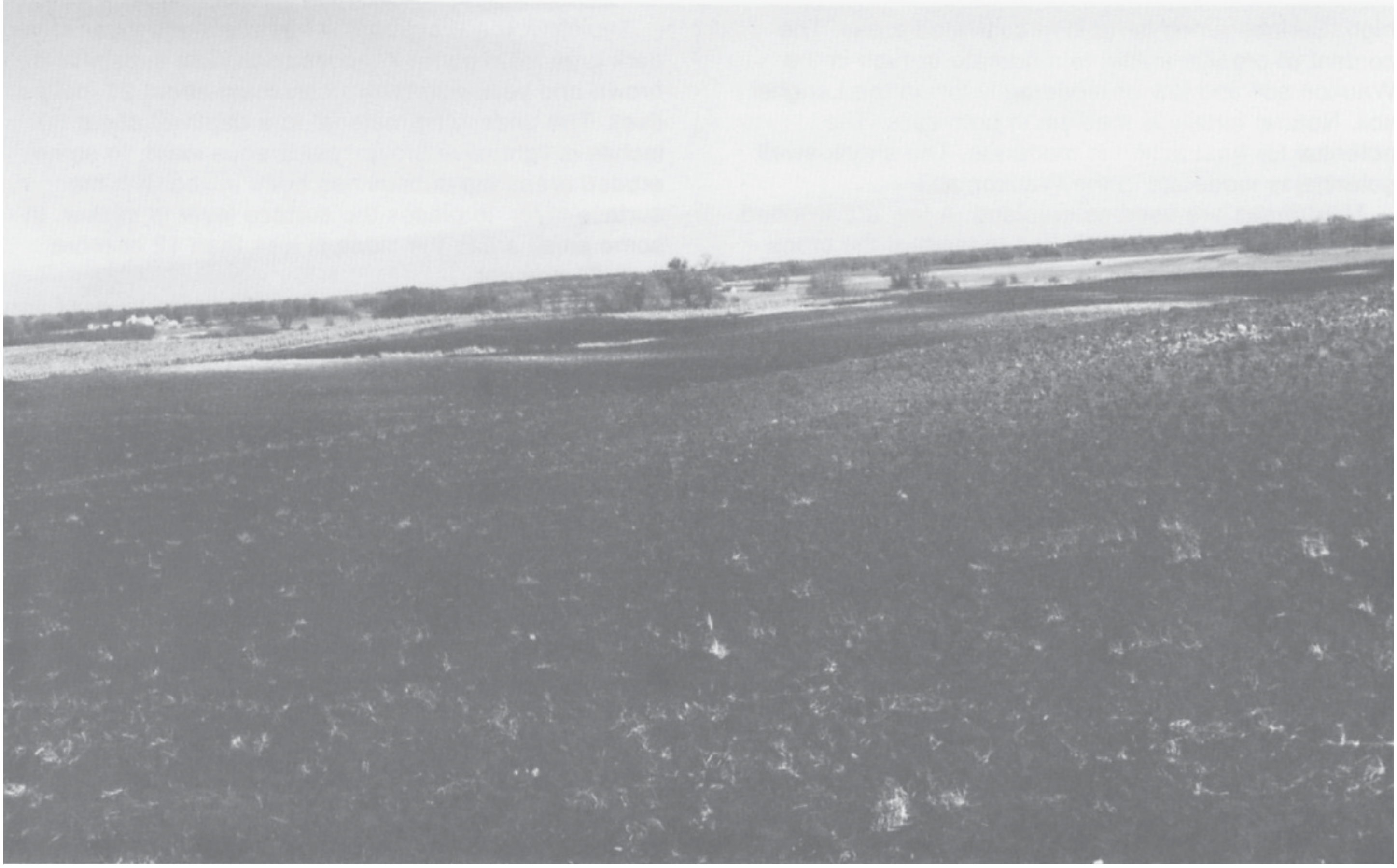

Figure 10.—An area of Waukon-Langhei loams, 4 to 12 percent slopes. The Langhei soil is in the lighter areas, and the Waukon soil is in the darker areas.

soil is VIIs. The woodland ordination symbol assigned to the Cushing and DeMontreville soils is 4R, and that assigned to the Mahtomedi soil is 2R.

967C—Waukon-Langhei loams, 4 to 12 percent slopes. These gently sloping and sloping, well drained soils are on end and ground moraines (fig. 10). The Langhei soil is on the crest of hills. The Waukon soil is on broad, convex side slopes, summits, and shoulder slopes. Areas are irregular in shape and range from 5 to 30 acres in size. They are about 50 to 60 percent Waukon soil and 30 to 40 percent Langhei soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Waukon soil has a surface layer of black loam about 8 inches thick. The subsoil is dark brown and dark yellowish brown loam about 18 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some eroded areas the subsoil has been mixed with the surface layer. In places the surface layer is thicker. In some small areas the slope is less than 4 or more than 12 percent.

Typically, the Langhei soil has a surface layer of black and very dark brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown, calcareous loam. In some small areas the slope is less than 4 or more than 12 percent.

Included with these soils in mapping are small areas of Flom and Gonvick soils, which make up 5 to 15 percent of the unit. The poorly drained Flom soils are in drainageways, swales, and depressions. The moderately well drained Gonvick soils are at the lower elevations. Also included are small areas of organic soils.

Air and water move through the Waukon and Langhei soils at a moderate rate. The available water capacity is high. Surface runoff is rapid in cultivated areas. The content of organic matter is moderate or high in the Waukon soil and low or moderately low in the Langhei soil. Natural fertility is medium in both soils. The potential for frost action is moderate. The shrink-swell potential is moderate in the Waukon soil.

Most areas are used as cropland. A few are wooded. These soils are fairly well suited to most of the crops commonly grown in the county. The main management needs are measures that control water erosion, improve fertility, and conserve moisture. Applying a system of conservation tillage, returning crop residue to the soils, and including grasses and legumes in the cropping sequence conserve moisture and help to control erosion. In some areas grassed waterways are needed to prevent gullying.

These soils are well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet results in surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

The Waukon soil is fairly well suited to woodland. Productivity is moderately high. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping. Commercial trees do not grow naturally on the Langhei soil, which originally supported native grasses.

The land capability classification is IIIe. The woodland ordination symbol assigned to the Waukon soil is 4A. No woodland ordination symbol is assigned to the Langhei soil.

967D—Waukon-Langhei loams, 12 to 25 percent slopes. These moderately steep and steep, well drained soils are on end and ground moraines. The Langhei soil is on the crests of hills. The Waukon soil is on broad, convex side slopes and summits. Areas are irregular in shape and range from 5 to 25 acres in size. They are about 45 to 55 percent Waukon soil and 35 to 45 percent Langhei soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Waukon soil has a surface layer of very dark gray loam about 7 inches thick. The subsoil is dark brown and yellowish brown clay loam about 21 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some eroded areas the subsoil has been mixed with the surface layer. In places the surface layer is thicker. In some small areas the slope is less than 12 or more than 25 percent.

Typically, the Langhei soil has a surface layer of very dark grayish brown and dark grayish brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some small areas the slope is less than 12 or more than 25 percent.

Included with these soils in mapping are small areas of Flom and Gonvick soils, which make up 5 to 15 percent of the unit. The poorly drained Flom soils are in drainageways and swales. The moderately well drained Gonvick soils are at the lower elevations.

Air and water move through the Waukon and Langhei soils at a moderate rate. The available water capacity is high. Surface runoff is rapid in cultivated areas. The content of organic matter is moderate or high in the Waukon soil and low or moderately low in the Langhei soil. Natural fertility is medium in both soils. The potential for frost action is moderate. The shrink-swell potential is moderate in the Waukon soil.

Most areas are used as cropland. A few are wooded. Because of the slope and the hazard of water erosion, these soils are unsuited to cultivated crops. They are fairly well suited to hay and pasture. Suitable species of grasses and legumes include alfalfa, birdsfoot trefoil, smooth bromegrass, switchgrass, and big bluestem. Overgrazing or grazing when the soils are wet causes excessive runoff and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. The slope limits the effectiveness of windbreaks. Water erosion is a severe hazard unless a plant cover protects the surface and site preparation is limited to the area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

The Waukon soil is fairly well suited to woodland. Productivity is moderately high. The main limitation is the slope. Erosion is a hazard on logging roads and skid trails. The use of equipment is limited by the slope and is further limited during the winter by slippery snow. Plant competition around new seedlings is a management concern. Seedlings grow well if competing vegetation is controlled by herbicides or by clipping. Commercial trees do not grow naturally on the Langhei soil, which originally supported native grasses.

The land capability classification is VIe. The woodland ordination symbol assigned to the Waukon soil is 4R. No woodland ordination symbol is assigned to the Langhei soil.

1015—Psamments, nearly level to sloping. These excessively drained soils are mainly in built-up urban areas and around highway interchanges on till plains and outwash plains. They consist of dominantly sandy material that has been excavated or filled during site preparation for a specific use. Areas are irregular in shape and range from 3 to 20 areas in size.

The soil material typically is loamy sand or sand. In some areas, however, it is gravelly loamy sand or gravelly sand. In other areas loamy material has been returned to the surface, so that the suitability for plant growth is improved.

Included with these soils in mapping are small areas of moderately steep soils, which make up 10 to 15 percent of the unit.

Most of the acreage is idle land that supports a sparse cover of grasses and shrubs. Because the properties of the soil material vary, onsite investigation is necessary before specific land use decisions can be made.

No land capability classification or woodland ordination symbol is assigned.

1029—Pits, gravel. This map unit consists of active or recently abandoned gravel pits from which sand or gravel has been removed. Areas are irregular in shape and range from 3 to about 40 acres in size.

A few of the gravel pits have been leveled, shaped, and reseeded. Unreclaimed areas are unsuitable as cropland, mainly because of droughtiness. Because the properties of the soil material vary, onsite investigation is necessary before land use decisions can be made.

No land capability classification or woodland ordination symbol is assigned.

1054—Prebish and Histosols, ponded. These soils are in draws and low areas that intermittently receive water from the surrounding watersheds. They generally are ponded because of beaver dams. The Histosols are very poorly drained, organic soils. The Prebish soil is a very poorly drained, mineral soil. Areas are irregular in shape and range from 5 to about 200 acres in size. The Prebish soil is dominant in some areas and the Histosols in other areas. The two soils have similar behavior characteristics, and separating them in mapping was not considered important for the objectives of this survey.

Typically, the Prebish soil has a surface layer of black sandy loam about 18 inches thick. The subsoil is dark gray, mottled sandy loam about 28 inches thick. The underlying material to a depth of about 60 inches is dark brown, mottled sandy loam. In some areas the subsoil is brighter colored. In other areas the soil is finer textured.

Typically, the texture of the Histosols ranges from muck to peat. These soils generally are layered.

Included with these soils in mapping are areas of the moderately well drained Alstad and well drained Cushing and Kandota soils on toe slopes. Also included are the moderately well drained Wykeham and Osakis soils on slight rises. Included soils make up about 10 to 15 percent of the unit.

Air and water move through the Prebish soil at a moderately slow rate. The available water capacity and organic matter content are high in this soil. Surface runoff is ponded.

Some areas support cattails, sedges, and rushes, and others support hardwoods. The kind of vegetation in a given area depends on the landscape position and the length of time that the area has been ponded. All areas are undeveloped. These soils are unsuited to most agricultural and engineering uses. They provide excellent habitat for wetland wildlife (fig. 11).

The land capability classification is VIIIw. The woodland ordination symbol assigned to the Prebish soil is 3W. No woodland ordination symbol is assigned to the Histosols.

1055—Aquolls and Histosols, ponded. These soils are in closed depressions that generally are ponded by 1 to 4 feet of water throughout the year. Some areas become dry in late summer or during droughty years, but most areas have open water during the growing season. The vegetation is cattails, reeds, sedges, and other water-tolerant plants. Areas are elongated and range from 5 to 130 acres in size. The Aquolls are dominant in some areas and the Histosols in other areas. The two soils have similar behavior characteristics, and separating them in mapping was not considered important for the objectives of this survey.

Most areas are undeveloped. These soils are unsuited to most agricultural and engineering uses.

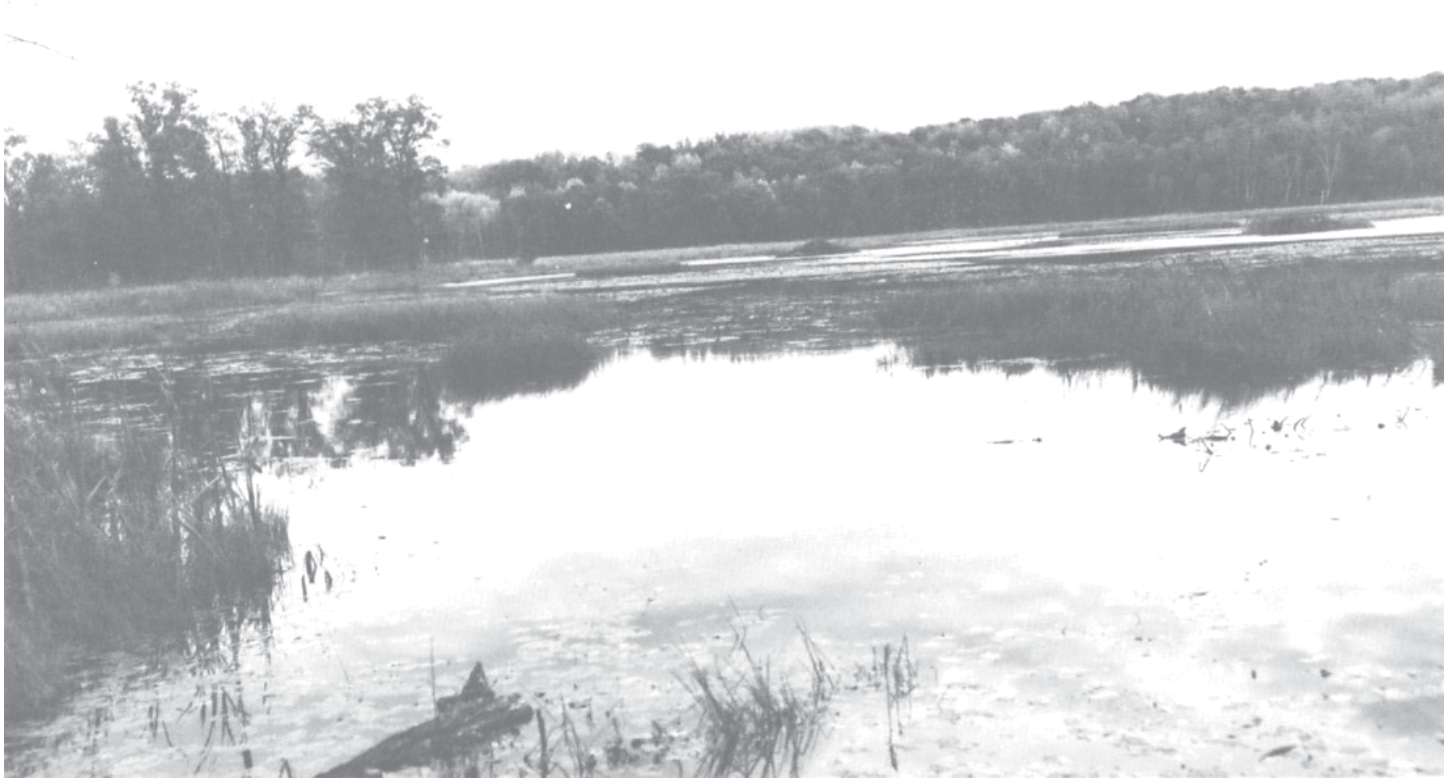

Figure 11.—An area of Prebish and Histosols, ponded. Several beaver lodges are in the background.

They provide excellent habitat for wetland wildlife. They provide nesting, mating, and escape areas for waterfowl, furbearers, and upland game.

The land capability classification is VIIIw. No woodland ordination symbol is assigned.

1926—Bowstring-Aquents complex. These nearly level, very poorly drained soils are on flood plains along the major streams. They are frequently flooded. Areas are irregular in shape and range from 5 to 400 acres in size. They are about 70 percent Bowstring soil and 20 percent Aquents. The two soils occur as areas so small or so intricately mixed that separating them in mapping was not practical.

Typically, the Bowstring soil has a surface layer of black muck about 10 inches thick. The subsoil is about 26 inches of stratified black muck and gray, mottled sand. The underlying material to a depth of about 60 inches is grayish brown, mottled sand that has layers of black muck. In some areas the soil is not underlain by sandy material or is not stratified.

The Aquents are wet, mineral soils on rises, sandbars, and islands along the main stream channels and in old oxbows. The texture ranges from silt loam to gravelly coarse sand, and the soils typically are layered.

Included with these soils in mapping are the somewhat excessively drained Arvilla and excessively drained Hubbard and Menahga soils on the toe slopes of terraces above the flood plains or on small islands that have been cut off by the river channel. Included soils make up about 10 percent of the unit.

Air and water move through the Bowstring soil and the Aquents at a moderately rapid to moderately slow rate. The available water capacity and organic matter content vary. Surface runoff is very slow. The seasonal high water table is within a depth of 2 feet.

Most of the acreage is idle land. Some areas are used as unimproved pasture. Because of the wetness and the flooding, these soils are unsuitable as cropland and as sites for most engineering uses and are poorly suited to pasture, woodland, and windbreaks. They provide food and cover for wetland wildlife (fig. 12).

The land capability classification of the Bowstring soil is VIw. The Aquents are not assigned to a land capability classification. Neither the Bowstring soil nor the Aquents are assigned to a woodland ordination symbol.

1927—Clotho sandy loam. This nearly level, poorly drained, calcareous soil is on broad flats and the rims of depressions on ground moraines between drumlins. Areas vary in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black, calcareous sandy loam about 12 inches thick. The subsurface layer is very dark grayish brown, mottled, calcareous sandy loam about 4 inches thick. The subsoil is dark grayish brown and yellowish brown, mottled, calcareous sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous sandy loam. In some areas the soil has an accumulation of lime in the upper 16 inches. In other areas the surface layer and subsoil have no carbonates.

Included with this soil in mapping are small areas of Runeberg, Paddock, and Wykeham soils, which make up 5 to 15 percent of the unit. The very poorly drained Runeberg soils are in depressions and low areas between drumlins. The somewhat poorly drained Paddock and moderately well drained Wykeham soils are on rises and in the more sloping areas.

Air and water move through the Clotho soil at a moderately slow rate. The available water capacity is moderate. Surface runoff is slow in cultivated areas. The seasonal high water table is at a depth of 0.5 foot to 3.0 feet. Organic matter content is high, and natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland or pasture. If drained, this soil is well suited to most of the crops commonly grown in the county. The major limitation is the wetness. A drainage system can remove excess water if suitable outlets are available. If the soil is worked when it is wet, it becomes hard and cloddy as it dries. Returning crop residue to the soil and applying manure help to maintain tilth. Some crops are adversely affected by the high content of lime in this soil. Crop varieties that are tolerant of lime should be selected for planting. In some areas stones interfere with cultivation. Rock picking may be needed to remove the stones from the fields.

If drained, this soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of the wetness and the high content of lime. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw. No woodland ordination symbol is assigned.

1932—Runeberg sandy loam. This nearly level, poorly drained soil is in slightly concave depressions and drainageways on glacial moraines. Areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark gray sandy loam about 3 inches thick. The subsoil is mottled sandy loam about 15 inches thick. It is grayish brown in the upper part and yellowish brown in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous sandy loam. In some areas the soil has a thicker subsoil and is deeper to calcareous, loamy till. In other areas the surface layer is thicker or is loam. In a few areas the soil has free carbonates throughout.

Included with this soil in mapping are small areas of Wykeham soils, which make up about 5 to 15 percent of the unit. These moderately well drained soils are on rises and in the more sloping areas.

Air and water move through the Runeberg soil at a moderately slow or slow rate. The available water capacity is high. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet. The shrink-swell potential is moderate. Organic matter content is high or very high, and natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland. If drained, this soil is well suited to most of the crops commonly grown in the county. The major limitation is the wetness. A drainage system can remove excess water if suitable outlets are available. If worked when wet, this soil

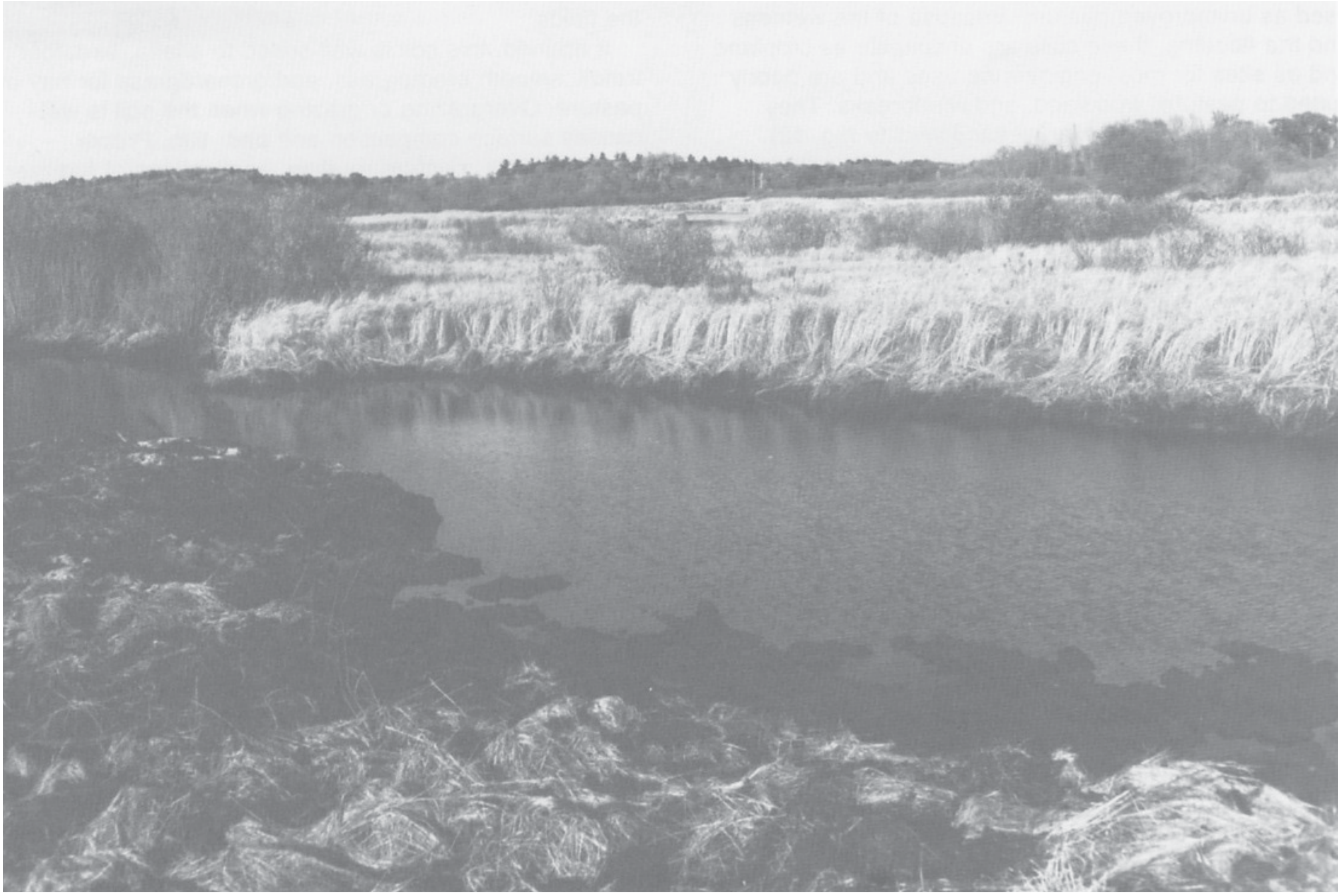

Figure 12.—Wetland wildlife habitat in an area of the Bowstring-Aquents complex along the Long Prairie River.

becomes cloddy and hard as it dries. Returning crop residue to the soil and applying manure help to maintain tilth.

If drained, this soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, applications of fertilizer and lime, pasture rotation, weed control, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the wetness. The use of equipment is limited during wet periods, when the soil is soft and cannot support heavy equipment. Harvesting equipment should be used only when the ground is frozen. Because of the wetness, the seedling mortality rate is moderate. It can be reduced by selecting suitable species for planting. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow.

The land capability classification is IIw. The woodland ordination symbol is 3W.

1943—Roscommon loamy sand. This nearly level, poorly drained and very poorly drained soil is in depressions and old drainageways on outwash plains. Areas are elongated and range from 5 to 120 acres in size.

Typically, the surface layer is very dark brown loamy sand about 9 inches thick. The subsoil is grayish brown and light brownish gray, mottled sand about 27 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled sand. In some areas the surface layer is thicker. In other areas it is an organic layer as much as 16 inches thick.

Included with this soil in mapping are small areas of Markey and Meehan soils, which make up about 15 percent of the unit. The very poorly drained, organic Markey soils are in depressions. The somewhat poorly drained, nearly level Meehan soils are on slightly elevated flats and on the rims of depressions.

Air and water move through the Roscommon soil at a rapid rate. The available water capacity is low. Surface runoff is very slow or ponded. The seasonal high water table is 1 foot above to 1 foot below the surface. Organic matter content is high or very high, and natural fertility is low. The potential for frost action is moderate.

Most areas are used as pasture or hayland. This soil is poorly suited to most of the crops commonly grown in the county. The main management needs are measures that reduce wetness and improve fertility. A drainage system can remove excess water if suitable outlets are available. Applying fertilizer and manure or returning crop residue to the soil improves fertility.

If drained, this soil is fairly well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. The wetness is a major limitation. The best suited species are those that can withstand the wet conditions. Overgrazing or grazing when the soil is wet results in compaction and deterioration of the pasture. Proper stocking rates, pasture rotation, applications of lime and fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The main limitation is the wetness. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment. Because of the wetness, the seedling mortality rate is moderate. It can be reduced by selecting suitable species for planting. The wetness hinders planting and thus restricts reforestation. Trees on this soil are shallow rooted and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow.

The land capability classification is IVw. The woodland ordination symbol is 3W.

1956—Staples loamy sand. This nearly level, poorly drained soil is in plane or concave areas along the edges of drainageways and shallow depressions on sand-mantled glacial moraines and drumlins. Areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is black loamy sand about 9 inches thick. The subsurface layer is about 19 inches thick. The upper part is dark grayish brown, mottled loamy sand, and the lower part is grayish brown, mottled sand. The subsoil is grayish brown, mottled sandy loam about 19 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, dense till that crushes to sandy loam. In some areas the sandy material is more than 40 or less than 20 inches thick. In other areas the surface layer is thicker. In places the slope is more than 2 percent.

Included with this soil in mapping are small areas of Cathro, Huntersville, Nymore, Redeye, and Rockwood soils, which make up 5 to 10 percent of the unit. The very poorly drained, organic Cathro soils are in depressions. The moderately well drained Huntersville soils are at the higher elevations. The well drained Redeye and Rockwood and somewhat excessively drained Nymore soils also are at the higher elevations. They are more sloping than the Staples soil.

Air and water move through the upper part of the Staples soil at a moderate rate and through the lower part at a very slow rate. The available water capacity is moderate. Surface runoff is slow. The seasonal high water table is at a depth of 0.5 foot to 2.0 feet. The shrink-swell potential is low. Organic matter content is moderate or high, and natural fertility is medium. The potential for frost action is high.

Most areas are used as cropland. If drained, this soil is fairly well suited to most of the crops commonly grown in the county. The major limitation is the wetness. A drainage system can remove excess water if suitable outlets are available. Returning crop residue to the soil and applying manure help to maintain tilth and increase the organic matter content.

If drained, this soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and Garrison creeping foxtail for hay or pasture. A drainage system is needed. Applications of fertilizer, pasture rotation, weed control, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs grown as windbreaks and environmental plantings on this soil should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to woodland. Productivity is moderate. The wetness is the major limitation. The use of equipment is restricted during wet periods, when the soil is soft and cannot support heavy equipment. Because of the wetness, the seedling mortality rate is moderate. It can be reduced by selecting suitable species for planting.

The land capability classification is IIIw. The woodland ordination symbol is 2W.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 266,000 acres in the survey area, or about 42 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in associations 1, 2, 3, 4, and 8, which are described under the heading "General Soil Map Units." Most of the prime farmland is used for crops, mainly corn, hay, and oats.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

In 1982, approximately 130,000 acres in Todd County was used for corn or soybeans; 70,000 acres for small grain, primarily oats; and 89,400 acres for hay, primarily alfalfa and alfalfa-grass mixtures *(6)*. Pasture is the principal land use in stony areas, on wetlands adjacent to marshes, and in some wooded areas.

Soil productivity ranges from marginal to high. Good management can increase productivity and conserve the soil. The main management needs in the county are measures that control water erosion and soil blowing, reduce the wetness of the more poorly drained soils, help to overcome moisture deficiencies in well drained to excessively drained soils, improve fertility and tilth, and control weeds.

Most of the cropland in the county is subject to water erosion or soil blowing. The hazards of water erosion and soil blowing range from slight to severe. As topsoil is removed through erosion, nutrients and organic matter also are removed. The eroding sediment settles at the base of slopes or in nearby depressions, or it enters streams, rivers, and lakes, where it adversely affects water quality.

Water erosion is a hazard on sloping soils, such as Waukon, Kandota, and Cushing soils. Examples of measures that help to control erosion are a cropping sequence that includes grasses and legumes, crop residue management, conservation tillage, contour farming, contour stripcropping, grassed waterways, terraces, diversions, and sediment- and water-control basins. Contour farming, contour stripcropping, and terraces are most effective in areas where slopes are long and uniform, such as areas of Flak, Holdingford, and Rockwood soils.

Conservation tillage is any tillage or planting system that leaves part or all of the residue from the previous crop on the soil surface. Examples are full-width tillage with a chisel plow or disk, strip tillage, ridge planting, and no-till planting. Crop residue management and conservation tillage improve soil structure and tilth, increase the rate of water infiltration, and reduce the runoff rate and the hazard of erosion. Other benefits derived from conservation tillage include reduced fuel consumption and machinery investment costs, substantial savings in time and labor, and moisture conservation.

Soil blowing can be a problem throughout the county, but it is especially serious on the sandy soils along the Sauk, Long Prairie, and Wing Rivers. The most common soils in these areas are Hubbard, Sverdrup, Zimmerman, Arvilla, Menahga, and Mahtomedi soils. Soil blowing occurs mainly on bare soils in the fall or early spring. It can be controlled by leaving crop residue on the surface, by leaving the surface of fall-plowed fields rough and cloddy, by planting field windbreaks, by wind stripcropping, and by applying a system of conservation tillage.

Wetness is a limitation in many nearly level or depressional soils, especially those in the areas of glacial till in the western part of the county. Flom, Blomford, and Forada soils are examples. A drainage system is needed to control ponding and to lower the water table below the root zone. Open ditches remove excess surface water and provide outlets for subsurface tile drainage systems. Drainage tile can be installed in most of the naturally wet soils. The spacing of subsurface drainage lines depends on the soil type and the depth at which tile drains can be installed. Generally, the finer the soil texture, the closer the space needed between tile lines.

Moisture deficiencies occur in most years on the well drained to excessively drained soils, such as Hubbard, Zimmerman, Arvilla, Sioux, Menahga, and Mahtomedi soils. The available water capacity is moderate or low in these soils. As a result, regular additions of water are needed. If these soils are irrigated, a wide variety of crops can be grown. Irrigation is especially beneficial in areas where speciality crops are grown. Conservation tillage can improve the efficiency of irrigation by reducing the runoff and evaporation rates and by controlling erosion. Test well borings are needed to determine if enough water is available for irrigation.

The acreage of irrigated crops in the county is expected to increase in the future. The best potential for irrigation is on the terraces along the Long Prairie River and in areas along the Sauk and Wing Rivers.

Good tilth allows soils to warm up more quickly in the spring and improves the availability of plant nutrients. Measures that maintain good tilth increase the rate of water infiltration and help to provide a good seedbed. Tilling when the soil is wet can cause compaction and can damage soil structure. Fall tillage, which is common on moderately fine textured and fine textured soils, increases the hazard of erosion. Applying a chisel-plow or ridge-plant system on these soils reduces this hazard while still providing a suitable surface for seedbed preparation in the spring. Returning crop residue to the soil and applying manure improve tilth and increase the content of organic matter. A cropping sequence that includes alfalfa-grass mixtures also improves tilth.

On most of the soils in the county, crops respond well to applications of fertilizer. They do not respond so well in some areas, such as those where the soils are limited by droughtiness, excessive wetness, or nutrient imbalances. A good fertility management program takes all of the aspects of plant growth into account. The need for fertilizer depends on the soil type, past and present management, the degree of erosion, and the crop to be planted. Soil tests can give a good indication of the type and amount of fertilizer to be applied. They should reflect the major soil types within each field.

Weeds can be controlled by applications of herbicide. Texture, organic matter content, and reaction influence the effectiveness of herbicide, the application rate, and carry-over.

A significant acreage in Todd County is used for hay and pasture. In many areas the pasture has been improved by the removal of trees or stones or by a drainage system. Because of these improvements, these areas are suitable as cropland. They generally are converted to cropland where soil productivity and land values are high.

Pasture and hayland can be improved by applications of fertilizer, pasture rotation, weed control, and timely deferment of grazing. If the pasture is renovated and reseeded, species selection should be based on the soil type and the degree of wetness. Current information about variety selection and species adaptation can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

The deep, well drained to somewhat poorly drained soils, such as Normania, Waukon, Rockwood, Ves, Flak, Lowlein, and Holdingford soils, are suited to the widest range of forage species. These include alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, timothy, orchardgrass, Kentucky bluegrass, and reed canarygrass. Also, warm-season grasses, including big bluestem, indiangrass, and switchgrass, grow well during July and August on these soils. The cool-season and warm-season species also grow well on the somewhat poorly drained or poorly drained Flom, Coriff, Forada, Roliss, and Paddock soils.

On the poorly drained or very poorly drained Blomford, Hangaard, Seelyeville, Markey, and Runeberg soils, the only suitable forage species are those that can withstand wet conditions. These species include reed canarygrass, creeping foxtail, redtop, birdsfoot trefoil, alsike clover, and ladino clover. If drained, these soils also are suitable for timothy, smooth bromegrass, Kentucky bluegrass, and red clover.

The moderately well drained to excessively drained soils, including Hubbard, Sverdrup, Zimmerman, Cushing, Arvilla, Sioux, Dorset, DeMontreville, Mahtomedi, and Menahga soils, usually provide forage in the spring and early summer and again in the fall, when the amount of precipitation is adequate. During the summer months, droughty conditions limit forage production. Alfalfa, red clover, birdsfoot trefoil, smooth bromegrass, orchardgrass, timothy, Kentucky bluegrass, and intermediate wheatgrass grow well when adequate moisture supplies are available.

Well drained to excessively drained soils are well suited to warm-season grasses, including big bluestem, little bluestem, indiangrass, switchgrass, and sideoats grama. If proper management is applied, these species provide good forage during the summer months and can be used along with cool-season species to provide a full-season forage program.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

In the latter part of the 19th century, the timber industry was an important part of the economy in Todd County. Eastern white pine and red pine were logged in the eastern part of the county. Large volumes of native hardwoods were shipped to St. Cloud and the Twin Cities.

Parts of Todd County currently are forested. Most of the woodland is privately owned. About 80 percent of the sand plain in the northeast corner of the county supports trees, mainly jack pine and aspen and birch and other hardwoods. Forested areas in the southern part of the county support aspen, basswood, elm, red maple, oak, and tamarack. Those in the northern part mainly support elm, oak, and maple, but some areas include stands of Norway spruce. Tamarack is common in low areas.

Red pine is the main reforestation species planted in the northeastern part of the county. Hardwoods are commonly harvested for lumber, and softwoods, such as jack pine and aspen, are harvested for pulpwood.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

The yield data for quaking aspen, bigtooth aspen, balsam poplar, and eastern white pine were obtained from a technical bulletin published by the University of Minnesota *(3)*; for red pine, jack pine, black spruce, and paper birch from a bulletin published by the Ontario Department of Lands and Forests *(7)*; for balsam fir and white spruce from a bulletin published by the U.S. Department of Agriculture *(5)*; for northern red oak and American basswood from a publication of the U.S. Department of Agriculture, Forest Service, the Wisconsin Department of Conservation, and the University of Wisconsin *(4)*; and for black ash and sugar maple from a bulletin published by the U.S. Department of Agriculture *(8)*.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the most important commercial species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Trees and shrubs are planted as farmstead windbreaks, field windbreaks, and wildlife plantings. Farmstead windbreaks are used to protect farmsteads against the wind and to control blowing snow. Field windbreaks are used primarily to control soil blowing on sandy soils. Wildlife plantings provide protection against the wind and food and cover for wildlife.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Todd County offers a variety of recreational opportunities. Camping, boating, hunting, fishing, and snowmobiling are the most common recreational activities. The county has 60 lakes more than 40 acres in size, especially in the southern and eastern parts. These lakes provide opportunities for fishing and other water sports. Lake Osakis, the largest lake, is more than 6,500 acres in size. Many of the lakes have developed areas of public access. The county has 43 lake resorts, 22 of which are along the shoreline of Lake Osakis. More than 4,000 acres of game management areas are open to the public for hunting.

Bertha, Browerville, Clarissa, Eagle Bend, Gray Eagle, Long Prairie, and Osakis have community parks and picnic areas. Golf courses are in Eagle Bend, Long Prairie, Osakis, and Staples. Two commercial camps provide opportunities for horseback riding and camping.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Most of the soils of Todd County are well suited to wildlife habitat. Cropland, pasture, and woodland are well interspersed throughout the county. The poorly drained and very poorly drained soils in depressions and potholes throughout the county have potential for wetland wildlife habitat. The natural wetlands in the eastern part of the county support a population of beaver and waterfowl. Some drainageways have potential for the development of water impoundments. More than 9,000 acres of publicly owned wildlife habitat is managed by the U.S. Fish and Wildlife Service or the Minnesota Department of Natural Resources. The most common mammals in the county are white-tailed deer, beaver, raccoons, rabbits, and squirrels. Ruffed grouse and pheasants inhabit the eastern part of the county. The most common fur-bearers are muskrats, raccoons, beaver, and mink. Waterfowl are throughout the county.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, indiangrass, wheatgrass, and ragweed.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, elm, basswood, hawthorn, dogwood, green ash, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, chokecherry, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cattails, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl-feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include pheasant, Hungarian partridge, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, red fox, raccoon, deer, and a few bears.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, and flooding affect absorption of the effluent. Large stones interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet.

Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to large stones, slope, and the hazard of cutbanks caving. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones. The performance of a system is affected by the depth of the root zone and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, and large stones affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, and slope affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 13). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates

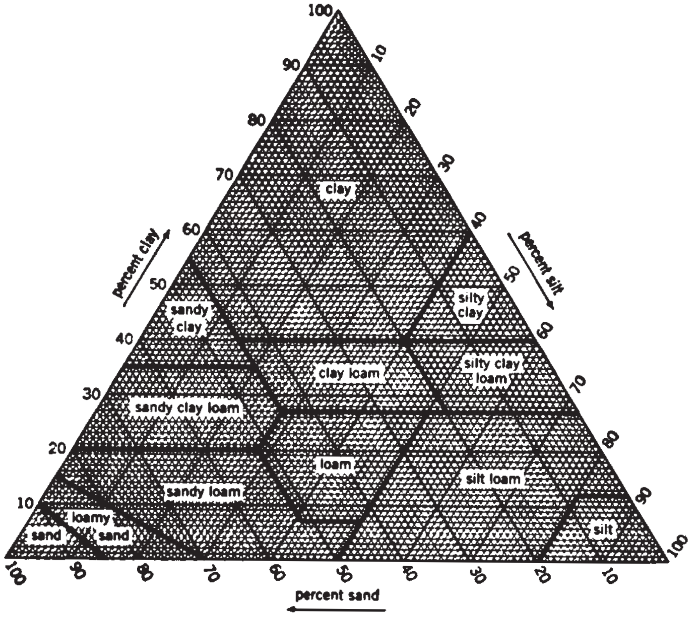

Figure 13.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous, loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 17 shows total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

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Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(10)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, frigid Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (9)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (10)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Alstad Series

The Alstad series consists of deep, moderately well drained soils on ground moraines in the uplands. These soils formed in noncalcareous sandy loam glacial till. Permeability is moderate in the solum and moderately slow in the underlying material. Slopes range from 1 to 3 percent.

Typical pedon of Alstad sandy loam, 2,560 feet north and 900 feet west of the southeast corner of sec. 1, T. 128 N., R. 33 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, light brownish gray (10YR 6/2) dry; moderate fine granular structure; friable; about 3 percent coarse fragments; medium acid; abrupt wavy boundary.

E—9 to 14 inches; dark grayish brown (10YR 4/2) sandy loam, light gray (10YR 7/2) dry; moderate thin platy structure; friable; about 3 percent coarse fragments; medium acid; clear wavy boundary.

Bt1—14 to 22 inches; dark brown (7.5YR 4/4) sandy clay loam; common fine faint dark brown (7.5YR 4/2) mottles; moderate medium subangular blocky structure; friable; about 4 percent coarse fragments; few thin dark brown (7.5YR 3/2) clay films on faces of peds; medium acid; clear wavy boundary.

Bt2—22 to 27 inches; brown (7.5YR 5/4) sandy clay loam; common fine faint dark brown (7.5YR 4/2) mottles; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; few thin dark brown (7.5YR 4/4) clay films on faces of peds; medium acid; clear wavy boundary.

Bt3—27 to 34 inches; dark brown (7.5YR 4/4) sandy loam; common fine distinct brown (7.5YR 5/2) mottles; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; common thin dark brown (7.5YR 3/2) clay films lining tubular pores; medium acid; clear wavy boundary.

BC—34 to 48 inches; dark brown (7.5YR 4/4) sandy loam; common fine distinct brown (7.5YR 5/2) mottles; moderate medium subangular blocky structure; friable; about 4 percent coarse fragments; many thin dark brown (7.5YR 3/2) clay films on faces of peds and lining tubular pores; medium acid; clear wavy boundary.

C—48 to 60 inches; dark brown (7.5YR 4/4) sandy loam; common fine distinct brown (7.5YR 5/2) mottles; moderate medium subangular blocky structure; friable; about 5 percent coarse fragments; medium acid.

The thickness of the solum ranges from 35 to 50 inches. The content of coarse fragments ranges from 2 to 15 percent throughout the solum. Most of the fragments range from 2 millimeters to 3 inches in size, but some are cobbles and a few are boulders.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly sandy loam or fine sandy loam, but the range includes loam and silt loam. The E horizon has value of 4 or 5 and chroma of 2 or 3 and is mottled in some pedons. It is dominantly sandy loam or fine sandy loam, but it is loam or silt loam in some pedons. Some pedons have an A/B or B/A horizon.

The Bt horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It has few or common, faint to prominent mottles. It is dominantly sandy loam or sandy clay loam, but in some pedons it has subhorizons of fine sandy loam or loam.

The C horizon has value of 4 or 5 and chroma of 2 to 4. It is sandy loam that has a low content of silt and commonly has a laminated appearance.

Arvilla Series

The Arvilla series consists of deep, somewhat excessively drained soils on outwash plains. These soils formed in loamy alluvium 14 to 25 inches deep over sand and gravel. Permeability is moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes are 0 to 12 percent.

Typical pedon of Arvilla sandy loam, 2 to 6 percent slopes, 1,200 feet south and 875 feet west of the northeast corner of sec. 11, T. 129 N., R. 35 W.

A—0 to 11 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; moderate medium granular structure; very friable; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

AB—11 to 16 inches; about 80 percent very dark gray (10YR 3/1) and 20 percent dark brown (10YR 3/3) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

Bw—16 to 21 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

2Bw—21 to 26 inches; dark brown (7.5YR 4/4) loamy sand; moderate medium subangular blocky structure; friable; about 14 percent coarse fragments; slightly acid; abrupt wavy boundary.

2BC—26 to 30 inches; dark brown (7.5YR 4/4) gravelly sand; single grained; loose; about 30 percent coarse fragments; neutral; abrupt wavy boundary.

2C—30 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grained; loose; about 20 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 36 inches. The depth to loamy sand or coarser textured material ranges from 14 to 25 inches. The mollic epipedon is 7 to 15 inches thick.

The A horizon has value of 2 or 3. Typically, it is sandy loam, but loam and coarse sandy loam are within the range.

The B horizon has hue of 2.5Y to 7.5YR, value of 3 or 4, and chroma of 1 to 4. It is sandy loam, loam, or coarse sandy loam. The 2B horizon has hue of 2.5Y to 7.5YR, value of 3 or 4, and chroma of 1 to 4. It is gravelly loamy sand, gravelly sand, gravelly coarse sand, coarse sand, loamy sand, or sand.

The 2C horizon has value of 4 to 6 and chroma of 2 to 6. It generally is stratified. It commonly is sand, coarse sand, or gravelly coarse sand. The content of gravel in this horizon ranges from 10 to 35 percent.

Blomford Series

The Blomford series consists of deep, poorly drained soils in shallow depressions on moraines and till plains in the uplands. Permeability is rapid in the upper part of the profile and moderate in the lower part. These soils formed in sandy outwash or eolian material 20 to 40 inches deep over silty or loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Blomford loamy sand, 500 feet east and 2,600 feet north of the southwest corner of sec. 16, T. 133 N., R. 32 W.

Ap—0 to 9 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; moderate fine granular structure; very friable; strongly acid; abrupt smooth boundary.

Eg1—9 to 19 inches; light brownish gray (10YR 6/2) sand, light gray (10YR 7/2) dry; common medium faint dark grayish brown (2.5Y 4/2) and common fine prominent strong brown (7.5YR 5/6) mottles; single grained; loose; medium acid; gradual wavy boundary.

Eg2—19 to 31 inches; grayish brown (10YR 5/2) sand; common fine prominent strong brown (7.5YR 5/6) mottles; single grained; loose; medium acid; clear wavy boundary.

2Btg—31 to 48 inches; olive gray (5Y 5/2) silt loam; common medium prominent reddish brown (5YR 4/4) and yellowish red (5YR 5/8) mottles; weak thin platy structure; friable; common faint very dark grayish brown (10YR 3/2) clay films lining pores; strongly acid; clear wavy boundary.

2C—48 to 60 inches; olive gray (5Y 5/2) silt loam; common medium prominent yellowish red (5YR 5/8) mottles; massive breaking to weak thin platy soil fragments; friable; strongly acid.

The thickness of the solum ranges from 36 to 60 inches. The depth to the loamy 2B horizon ranges from 20 to 40 inches. The depth to free carbonates ranges from 36 to 70 inches. The upper sediments generally do not have coarse fragments. In the lower sediments, however, the content of these fragments may be as much as 10 percent. Most of the fragments range from 2 millimeters to 3 inches in size.

The A and E horizons are dominantly loamy sand or sand, but the range includes fine sand and loamy fine sand. The A horizon has value of 2 to 4 and chroma of 1 or 2. The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 3 and commonly is mottled.

The 2B horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 or 2 and typically has distinct or prominent mottles. It is silt loam, loam, sandy clay loam, or fine sandy loam. It is strongly acid to neutral.

The 2C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 3. It is silt loam, sandy clay loam, or loam.

Blowers Series

The Blowers series consists of deep, moderately well drained soils on drumlins and ground moraines in the uplands. These soils formed in calcareous, loamy glacial till. Permeability is moderate in the upper part of the profile and very slow in the underlying till. Slopes range from 1 to 5 percent.

Typical pedon of Blowers sandy loam, 1 to 5 percent slopes, 42 feet south and 1,340 feet east of the northwest corner of sec. 32, T. 130 N., R. 34 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) sandy loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; about 10 percent coarse fragments; medium acid; abrupt wavy boundary.

E—6 to 12 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; weak thin platy structure; friable; about 10 percent coarse fragments; slightly acid; clear wavy boundary.

E/B—12 to 17 inches; about 70 percent dark grayish brown (10YR 4/2) sandy loam (E) and 30 percent dark yellowish brown (10YR 3/4) sandy loam (Bt); moderate fine subangular blocky structure; friable; about 12 percent coarse fragments; medium acid; clear wavy boundary.

B/E—17 to 27 inches; about 70 percent yellowish brown (10YR 5/6) sandy loam (Bt) and 30 percent grayish brown (10YR 5/2) sandy loam (E); moderate medium subangular blocky structure; friable; about 13 percent coarse fragments; common distinct very dark grayish brown (10YR 3/2) clay films in tubular pores and common faint dark yellowish brown (10YR 3/4) clay films on faces of peds; medium acid; clear wavy boundary.

Bt—27 to 34 inches; yellowish brown (10YR 5/4) sandy loam; common fine faint grayish brown (10YR 5/2) mottles; moderate thick platy structure parting to moderate fine subangular blocky; firm; about 14 percent coarse fragments; many distinct very dark brown (10YR 2/2) clay films in tubular pores and common distinct brown (10YR 5/3) clay films on faces of peds; neutral; clear wavy boundary.

BC—34 to 40 inches; yellowish brown (10YR 5/4) sandy loam; moderate medium platy structure; firm; about 13 percent coarse fragments; common distinct dark yellowish brown (10YR 4/4) clay films in tubular pores; few fine irregularly shaped light gray (10YR 7/2) filaments of lime; slight effervescence; mildly alkaline; abrupt wavy boundary.

Cd—40 to 60 inches; yellowish brown (10YR 5/4) dense till that crushes to sandy loam; moderate thin platy soil fragments; firm; about 12 percent coarse fragments; fine irregularly shaped light gray (10YR 7/2) accumulations of lime in seams; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 32 to 50 inches. The depth to free carbonates ranges from 32 to 46 inches. The content of coarse fragments is 2 to 15 percent throughout the profile. Most of the fragments are 2 millimeters to 8 inches in size.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. Most pedons have an E/B or B/E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 5. Part of the B horizon has mottles with chroma of 2 or less. The Cd horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 4 or 5.

Bluffton Series

The Bluffton series consists of deep, very poorly drained, moderately slowly permeable soils in depressions on moraines. These soils formed in a mantle of loamy material and in the underlying calcareous, loamy glacial till. Slopes are 0 to 1 percent.

Typical pedon of Bluffton loam, 800 feet west and 1,000 feet south of the northeast corner of sec. 6, T. 127 N., R. 35 W.

A1—0 to 3 inches; black (N 2/0) loam, dark gray (5Y 4/1) dry; weak fine and medium subangular blocky structure; very friable; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

A2—3 to 14 inches; black (N 2/0) loam, very dark gray (5Y 3/1) dry; weak fine and medium subangular blocky structure; very friable; about 3 percent coarse fragments; slightly acid; clear smooth boundary.

A3—14 to 20 inches; black (N 2/0) loam, dark gray (5Y 4/1) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

Bg—20 to 44 inches; gray (5Y 5/1) clay loam; many medium prominent strong brown (7.5YR 5/8) mottles; weak coarse subangular blocky structure; firm; about 2 percent coarse fragments; neutral; clear wavy boundary.

Cg—44 to 60 inches; gray (5Y 6/1) sandy loam; many fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 15 to 44 inches. The thickness of the mollic epipedon is commonly 10 to 20 inches but ranges to 24 inches.

The A horizon has hue of 10YR or 5Y, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 or 3 and chroma of 0. It is loam, silt loam, sandy loam, or sandy clay loam.

The B horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It has few to many mottles. It is clay loam, loam, or sandy clay loam.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It has few to many mottles. It is loam or sandy loam.

Bowstring Series

The Bowstring series consists of deep, very poorly drained, moderately rapidly permeable to moderately slowly permeable soils along flood plains on outwash plains, lake plains, and moraines. These soils formed in highly decomposed organic material over sandy material. Slopes are less than 1 percent.

The Bowstring soils in Todd County are taxadjuncts to the series because they have a mineral layer in the control section. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Bowstring muck, in an area of Bowstring-Aquents complex; 2,280 feet north and 110 feet east of the southwest corner of sec. 10, T. 129 N., R. 34 W.

Oa1—0 to 10 inches; sapric material, black (10YR 2/1) broken face and rubbed; mixed with light gray (10YR 6/1) sand grains; weak fine granular structure; very friable; slightly acid; clear wavy boundary.

Oa2—10 to 18 inches; sapric material, black (N 2/0) broken face and black (10YR 2/1) rubbed; mixed with sand grains; common medium prominent yellowish red (5YR 4/6) masses of bog iron; weak medium subangular blocky structure; very friable; medium acid; abrupt wavy boundary.

C1—18 to 23 inches; gray (5Y 5/1) sand that has strata of loamy sand; mixed with about 10 percent black (N 2/0) sapric material; single grained; loose; about 5 percent woody fragments; neutral; clear wavy boundary.

Oa3—23 to 36 inches; sapric material, black (N 2/0) broken face and black (10YR 2/1) rubbed; common fine yellowish red (5YR 5/6) masses of bog iron; massive; very friable; neutral; clear wavy boundary.

C2—36 to 60 inches; grayish brown (10YR 5/2) sand; many layers of black (10YR 2/1) sapric material about 0.5 inch thick; single grained; loose; neutral.

The depth to sandy material ranges from 20 to 50 inches. The organic part of the control section has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 and chroma of 0. The surface and subsurface tiers are dominantly sapric, but in some pedons they have thin layers of hemic material. Generally, sand grains are mixed with the organic material.

The C horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 or 2. It is mottled in some pedons. It is dominantly sand or loamy sand, but the range includes all sandy and loamy textures.

Braham Series

The Braham series consists of deep, well drained soils on glacial till plains and moraines. These soils formed in 20 to 40 inches of sandy material over silty and loamy glaciolacustrine sediments or glacial till. Permeability is rapid in the upper part of the profile and moderate in the lower part. Slopes range from 1 to 6 percent.

Typical pedon of Braham loamy sand, 1 to 6 percent slopes, 2,250 feet west and 46 feet south of the northeast corner of sec. 17, T. 133 N., R. 32 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; medium acid; abrupt smooth boundary.

E—9 to 24 inches; brown (10YR 5/3) sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; very friable; medium acid; abrupt wavy boundary.

2Bt1—24 to 30 inches; dark yellowish brown (10YR 4/4) silty clay loam; strong medium angular blocky structure; firm; many distinct dark brown (10YR 4/3) clay films on faces of peds and lining pores; medium acid; clear wavy boundary.

2Bt2—30 to 40 inches; yellowish brown (10YR 5/4) silty clay loam; strong medium angular blocky structure; firm; many distinct very dark grayish brown (10YR 3/2) clay films on faces of peds and lining pores; medium acid; clear wavy boundary.

2C—40 to 60 inches; yellowish brown (10YR 5/4) silt loam; massive breaking to moderate thin platy soil fragments; few faint dark brown (10YR 4/3) clay films lining pores and root channels; common fine irregularly shaped grayish brown (2.5Y 5/2) masses of lime; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 38 to 54 inches. The sandy mantle ranges from 20 to 40 inches in thickness. It has coarse fragments in some pedons. The content of these fragments in the underlying glacial till is as much as 10 percent. Most of the fragments are 2 millimeters to 3 inches in size.

The Ap or A horizon has value of 2 or 3 and chroma of 1 to 3. It is sand, fine sand, loamy sand, or loamy fine sand. The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is sand, fine sand, or loamy sand. The 2Bt and 2C horizons are silty clay loam, silt loam, or loam. The 2Bt horizon has value of 4 or 5 and chroma of 3 or 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 or 4.

Brainerd Series

The Brainerd series consists of deep, moderately well drained soils on ground moraines and drumlins. These soils formed in noncalcareous glacial till. Permeability is moderately rapid in the upper part of the solum and very slow in the lower part and in the underlying material. Slopes range from 1 to 4 percent.

Typical pedon of Brainerd sandy loam, 1 to 4 percent slopes, 36 feet west and 66 feet south of the northeast corner of sec. 13, T. 130 N., R. 32 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) sandy loam, gray (10YR 5/1) dry; weak fine granular structure; friable; about 10 percent coarse fragments; strongly acid; abrupt smooth boundary.

E—8 to 18 inches; about 80 percent dark brown (10YR 4/3) sandy loam and 20 percent dark grayish brown (10YR 4/2) sandy loam, pale brown (10YR 6/3) dry; weak thin platy structure; friable; about 14 percent coarse fragments; strongly acid; clear wavy boundary.

B/E—18 to 23 inches; about 80 percent strong brown (7.5YR 5/6) sandy loam (B) and 20 percent dark grayish brown (10YR 4/2) sandy loam (E); moderate medium subangular blocky structure; friable; about 12 percent coarse fragments; common faint dark brown (7.5YR 4/4) clay films on faces of peds; common light gray (10YR 7/2) clean sand grains and silt particles on faces of peds; strongly acid; clear wavy boundary.

Bt—23 to 36 inches; dark brown (7.5YR 4/4) sandy loam; common medium distinct brown (7.5YR 5/2) and pinkish gray (7.5YR 7/2) mottles; moderate medium subangular blocky structure; friable; about 14 percent coarse fragments; common faint dark brown (7.5YR 3/4) clay films on faces of peds; medium acid; clear wavy boundary.

BC—36 to 42 inches; dark brown (7.5YR 4/4) sandy loam; common fine distinct brown (7.5YR 5/2) and pinkish gray (7.5YR 6/2) mottles; weak thin platy structure parting to moderate fine subangular blocky; firm; about 10 percent coarse fragments; few faint dark brown (7.5YR 4/2) clay films on faces of peds; medium acid; gradual wavy boundary.

Cd—42 to 60 inches; dark brown (7.5YR 4/4) dense till that crushes to sandy loam; few fine distinct pinkish gray (7.5YR 6/2) mottles; weak thin platy structure; firm; about 15 percent coarse fragments; medium acid.

The thickness of the solum ranges from 30 to 48 inches. The depth to the dense till ranges from 20 to 40 inches. The content of coarse fragments ranges from 5 to 20 percent throughout the profile.

The A, E, and B horizons are sandy loam or fine sandy loam. The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 or 3. The B horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It has distinct or prominent mottles. The Cd horizon has value of 4 or 5 and chroma of 3 to 5. It has faint to prominent mottles with hue of 5YR to 10YR.

Cathro Series

The Cathro series consists of deep, very poorly drained soils in depressions on ground moraines and till plains. These soils formed in herbaceous organic material 16 to 50 inches deep over loamy glacial till. Permeability is moderately slow to moderately rapid in the organic material and moderately slow or moderate in the loamy underlying material. Slopes are less than 1 percent.

Typical pedon of Cathro muck, 1,000 feet south and 150 feet west of the northeast corner of sec. 30, T. 130 N., R. 34 W.

Oa1—0 to 12 inches; sapric material, black (10YR 2/1) broken face and rubbed, very dark brown (10YR 2/2) pressed; about 20 percent fiber unrubbed, less than 10 percent rubbed; weak fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.

Oa2—12 to 30 inches; sapric material, very dark grayish brown (10YR 3/2) broken face and pressed, very dark gray (10YR 3/1) rubbed; about 50 percent fiber unrubbed, less than 10 percent rubbed; weak medium platy structure; very friable; slightly acid; abrupt wavy boundary.

C—30 to 60 inches; dark gray (10YR 4/1) sandy loam; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; weak medium platy structure; friable; neutral.

The depth to the loamy C horizon ranges from 16 to 50 inches. The organic material has no free carbonates.

The organic part of the control section has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2.

The surface tier is hemic or sapric material that has a fiber content of 20 to 50 percent before rubbing. The fiber content after rubbing ranges from less than 5 percent to 20 percent. The subsurface tier is typically sapric material, but it has less than 10 inches of hemic material. The fiber content before rubbing ranges from less than 10 percent to 50 percent, and the fiber content after rubbing is less than 20 percent.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam, loam, silt loam, or clay loam.

Clotho Series

The Clotho series consists of deep, poorly drained, moderately slowly permeable soils on broad flats and near the rims of depressions on ground moraines and in areas between drumlins. These soils formed in calcareous, loamy glacial till. Slopes are 1 to 2 percent.

Typical pedon of Clotho sandy loam, 400 feet east and 2,000 feet north of the center of sec. 27, T. 130 N., R. 34 W.

A—0 to 12 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Ag—12 to 16 inches; very dark grayish brown (2.5Y 3/2) sandy loam, dark grayish brown (2.5Y 4/2) dry; common medium prominent brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Bg—16 to 20 inches; dark grayish brown (2.5Y 4/2) sandy loam; few fine prominent yellowish red (5YR 4/6) and brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; moderately alkaline; clear smooth boundary.

Bw—20 to 26 inches; yellowish brown (10YR 5/4) sandy loam; common fine prominent strong brown (7.5YR 5/6), light gray (10YR 6/1), and grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

C1—26 to 34 inches; yellowish brown (10YR 5/4) sandy loam; common medium distinct yellow (10YR 7/8) mottles; weak thick platy soil fragments; friable; about 3 percent coarse fragments; strong effervescence; irregularly shaped filaments or threads of lime; moderately alkaline; clear smooth boundary.

C2—34 to 60 inches; yellowish brown (10YR 5/4) sandy loam; common medium faint light brownish gray (10YR 6/2) mottles; weak thick platy soil fragments; friable; about 3 percent coarse fragments; strong effervescence; irregularly shaped filaments or threads of lime; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. The content of coarse fragments ranges from 2 to 20 percent throughout the profile.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 1 to 3, and chroma of 1 or 2. It is sandy loam or fine sandy loam. The B horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 2 to 4. It is typically sandy loam, but fine sandy loam and loam are within the range. The C horizon has hue of 10YR to 5Y, value of 5 or 6, and chroma of 2 to 4. It is typically sandy loam, but fine sandy loam is within the range.

Coriff Series

The Coriff series consists of deep, poorly drained soils on ground moraines. These soils formed in water-worked material over loamy, calcareous glacial till. Permeability is moderately rapid in the upper part of the profile and moderate in the underlying material. Slopes range from 0 to 2 percent.

The Coriff soils in Todd County formed under a colder climate than is typical for the series. This difference, however, does not significantly affect the use or management of the soils.

Typical pedon of Coriff sandy loam, 2,540 feet south and 60 feet east of the northwest corner of sec. 12, T. 128 N., R. 35 W.

Ap—0 to 12 inches; black (N 2/0) sandy loam, very dark gray (N 3/0) dry; weak medium and fine subangular blocky structure; friable; about 1 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—12 to 19 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 1 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Bg1—19 to 29 inches; grayish brown (2.5Y 5/2) loamy sand; mixed with some very dark gray (10YR 3/1) material; few medium distinct light yellowish brown (2.5Y 6/4) mottles; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Bg2—29 to 35 inches; olive gray (5Y 4/2) sandy loam; few medium distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

2Cg—35 to 60 inches; olive gray (5Y 5/2) loam; common medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 40 inches. The mollic epipedon ranges from 12 to 22 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is mottled in some or all parts. It is stratified with sandy loam, loamy sand, sand, or fine sand. The 2Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It commonly is mottled throughout.

Cushing Series

The Cushing series consists of deep, well drained, moderately permeable soils on moraines (fig. 14). These soils formed in noncalcareous, loamy glacial till. Slopes range from 2 to 45 percent.

Typical pedon of Cushing sandy loam, in an area of Cushing-DeMontreville-Mahtomedi complex, 15 to 45 percent slopes; 2,600 feet west and 300 feet south of the northeast corner of sec. 34, T. 131 N., R. 32 W.

A—0 to 3 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; about 7 percent coarse fragments; neutral; clear wavy boundary.

E—3 to 12 inches; brown (10YR 5/3) sandy loam, very pale brown (10YR 7/3) dry; weak thin platy structure; friable; about 7 percent coarse fragments; slightly acid; clear wavy boundary.

E/B—12 to 17 inches; about 80 percent brown (10YR 5/3) sandy loam (E) and 20 percent dark brown (7.5YR 4/4) sandy loam (Bt); weak thin platy structure; friable; about 7 percent coarse fragments; few distinct dark brown (7.5YR 4/4) clay films on faces of peds and in pores; slightly acid; gradual wavy boundary.

B/E—17 to 26 inches; about 75 percent dark brown (7.5YR 4/4) sandy loam (Bt) and 25 percent brown (10YR 5/3) sandy loam (E); firm; about 7 percent coarse fragments; weak fine subangular blocky structure; few distinct dark brown (7.5YR 4/4) clay films on faces of peds and in pores; slightly acid; clear irregular boundary.

Bt1—26 to 37 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate fine subangular blocky

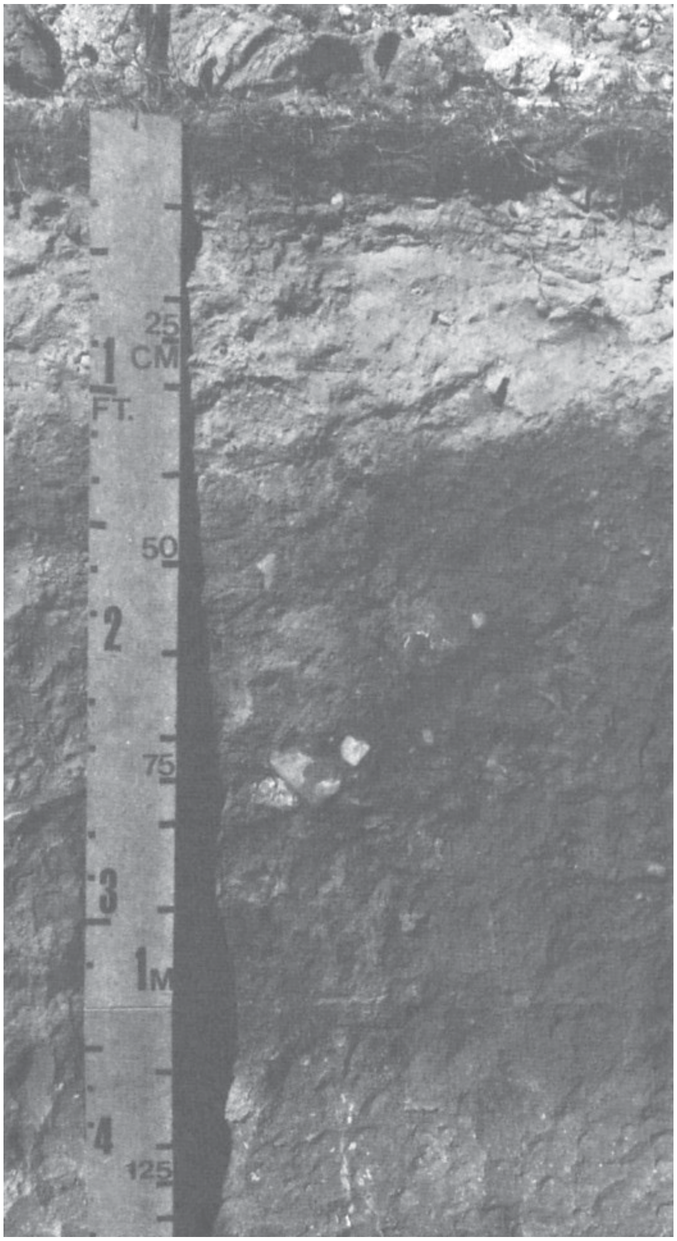

Figure 14.—Profile of Cushing sandy loam, 2 to 8 percent slopes.

structure; firm; about 7 percent coarse fragments; common distinct reddish brown (5YR 4/4) clay films on faces of peds and in pores; few very pale brown (10YR 7/3) sand grains on faces of peds; medium acid; clear smooth boundary.

Bt2—37 to 54 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate fine subangular blocky structure; firm; about 7 percent coarse fragments; common distinct reddish brown (5YR 4/4) clay films on faces of peds and in pores; medium acid; gradual wavy boundary.

C—54 to 60 inches; dark brown (7.5YR 4/4) sandy loam; massive breaking to moderate thin platy soil fragments; friable; about 7 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 24 to 55 inches. Free carbonates are leached from the control section. They generally are leached to a depth of 80 inches or more. The content of coarse fragments is generally 0 to 15 percent but is as much as 20 percent in parts of some pedons. Most of the fragments range from 2 millimeters to 3 inches in size, but some are cobbles and a few are boulders.

The A horizon has value of 2 to 4 and chroma of 1 to 3. It is sandy loam or fine sandy loam. The E horizon has value of 4 to 6 and chroma of 2 or 3. It commonly is sandy loam, but the range includes fine sandy loam and loam. The B horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 3 to 6. It typically is sandy loam or sandy clay loam, but in some pedons it has subhorizons of fine sandy loam or loam. The C horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or loam that has a low content of silt.

Dassel Series

The Dassel series consists of deep, very poorly drained soils on outwash plains and valley trains. These soils formed in distinctly stratified, loamy outwash sediments. Permeability is moderately rapid in the solum and rapid in the underlying material. Slopes are typically less than 1 percent.

The Dassel soils in Todd County formed under a colder climate than is typical for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Dassel mucky sandy loam, 1,900 feet east and 400 feet north of the southwest corner of sec. 11, T. 129 N., R. 32 W.

Ap—0 to 9 inches; black (N 2/0) mucky sandy loam, dark gray (10YR 4/1) and gray (10YR 5/1) dry; clean white (2.5Y N8/0) sand grains; weak fine granular structure; very friable; medium acid; abrupt wavy boundary.

AB—9 to 18 inches; very dark gray (10YR 3/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; common fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.

Bg1—18 to 24 inches; stratified, dark grayish brown (2.5Y 4/2) fine sandy loam; mixed with about 10 percent very dark gray (10YR 3/1) material; common fine distinct yellowish brown (10YR 5/6) and prominent yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; very friable; neutral; clear wavy boundary.

Bg2—24 to 31 inches; stratified, dark grayish brown (2.5Y 4/2) loamy fine sand; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium platy structure parting to weak fine subangular blocky; loose; neutral; clear wavy boundary.

Cg1—31 to 42 inches; light brownish gray (2.5Y 6/2) fine sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; mildly alkaline; clear wavy boundary.

Cg2—42 to 60 inches; light gray (2.5Y 7/2) sand that has thin bands of light brownish gray (2.5Y 6/2) loamy fine sand; common fine prominent yellowish brown (10YR 5/6) mottles; single grained; loose; mildly alkaline.

The thickness of the solum ranges from 20 to 50 inches. The depth to free carbonates ranges from 18 to 70 inches. The content of coarse fragments is 0 to 10 percent throughout the profile.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is dominantly fine sandy loam or sandy loam, but it is loam in some pedons and is mucky in many pedons.

The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It has distinct textural strata. It is mainly fine sandy loam, sandy loam, loamy sand, or loamy fine sand, but it has coarser or finer textured strata in some pedons.

The C horizon typically has hue of 2.5Y or 5Y, value of 5 to 8, and chroma of 1 or 2. It is dominantly sand, coarse sand, or loamy sand, but in many pedons it has strata of finer textured material or gravelly material.

DeMontreville Series

The DeMontreville series consists of deep, well drained soils on ground and end moraines. These soils formed in 20 to 40 inches of sandy material and in the underlying brownish, noncalcareous, loamy glacial till. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slopes range from 2 to 45 percent.

Typical pedon of DeMontreville loamy sand, in an area of Cushing-DeMontreville-Mahtomedi complex, 15 to 45 percent slopes; 500 feet north and 2,250 feet east of the southwest corner of sec. 5, T. 129 N., R. 32 W.

A—0 to 3 inches; very dark brown (10YR 2/2) loamy sand, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; about 10 percent coarse fragments; medium acid; abrupt smooth boundary.

E—3 to 23 inches; dark brown (10YR 4/3) loamy sand, very pale brown (10YR 7/3) dry; weak medium platy structure; very friable; about 10 percent coarse fragments; medium acid; clear wavy boundary.

2Bt1—23 to 30 inches; about 60 percent dark yellowish brown (10YR 4/4) sandy loam and 40 percent dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; about 10 percent coarse fragments; common thin dark brown (7.5YR 3/2) clay films on faces of peds and lining pores; medium acid; clear wavy boundary.

2Bt2—30 to 48 inches; about 80 percent dark brown (7.5YR 4/4) sandy loam and 20 percent dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; about 10 percent coarse fragments; common thin dark brown (7.5YR 4/2) clay films lining pores; medium acid; abrupt smooth boundary.

2C—48 to 60 inches; dark brown (7.5YR 4/4) sandy loam; weak thin platy structure; friable; about 8 percent coarse fragments; medium acid.

The thickness of the solum ranges from 30 to 50 inches. The depth to glacial till ranges from 20 to 40 inches. The content of coarse fragments is 0 to 10 percent in the sandy mantle and 8 to 20 percent in the 2B and 2C horizons.

The A and E horizons are dominantly loamy sand, but the range includes loamy fine sand, sand, and fine sand. The A horizon has value of 2 to 4 and chroma of 1 to 3. The E horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. Some pedons have an E/B or B/E horizon.

Some pedons have a B horizon. This horizon has hue of 10YR or 7.5YR. It is dominantly loamy sand or loamy coarse sand, but the range includes coarse sand, sand, fine sand, and loamy fine sand.

The 2B horizon has hue of 10YR to 5YR, value of 3 to 5, and chroma of 3 to 6. It is dominantly sandy loam, but the range includes sandy clay loam, loam, and fine sandy loam. This horizon has few to many clay films.

The 2C horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 4 to 6. It is dominantly sandy loam or coarse sandy loam, but the range includes loamy coarse sand.

Dorset Series

The Dorset series consists of deep, well drained soils on outwash plains and moraines (fig. 15). These soils formed in a thin mantle of loamy glacial alluvium and in the underlying sand and gravel. Permeability is moderately rapid in the upper part of the profile and rapid in the underlying sand and gravel. Slopes range from 2 to 12 percent.

The Dorset soils in Todd County do not have an E horizon, which is definitive for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Dorset sandy loam, 2 to 6 percent slopes, 2,200 feet south and 2,450 feet east of the northwest corner of sec. 33, T. 129 N., R. 32 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; very friable; less than 2 percent coarse fragments; neutral; abrupt smooth boundary.

Bt—8 to 14 inches; dark brown (7.5YR 4/4) sandy loam; weak medium platy structure parting to weak fine subangular blocky structure; friable; about 3 percent coarse fragments; few faint dark brown (7.5YR 3/4) clay films lining pores; slightly acid; abrupt smooth boundary.

2Bt—14 to 18 inches; dark yellowish brown (10YR 4/4) gravelly sand; single grained; loose; about 20 percent coarse fragments; common faint dark brown (7.5YR 3/4) clay bridges; slightly acid; clear smooth boundary.

2BC—18 to 34 inches; yellowish brown (10YR 5/4) gravelly sand; single grained; loose; about 18 percent coarse fragments; slightly acid; abrupt smooth boundary.

2C—34 to 60 inches; pale brown (10YR 6/3) gravelly coarse sand; single grained; loose; about 22 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free

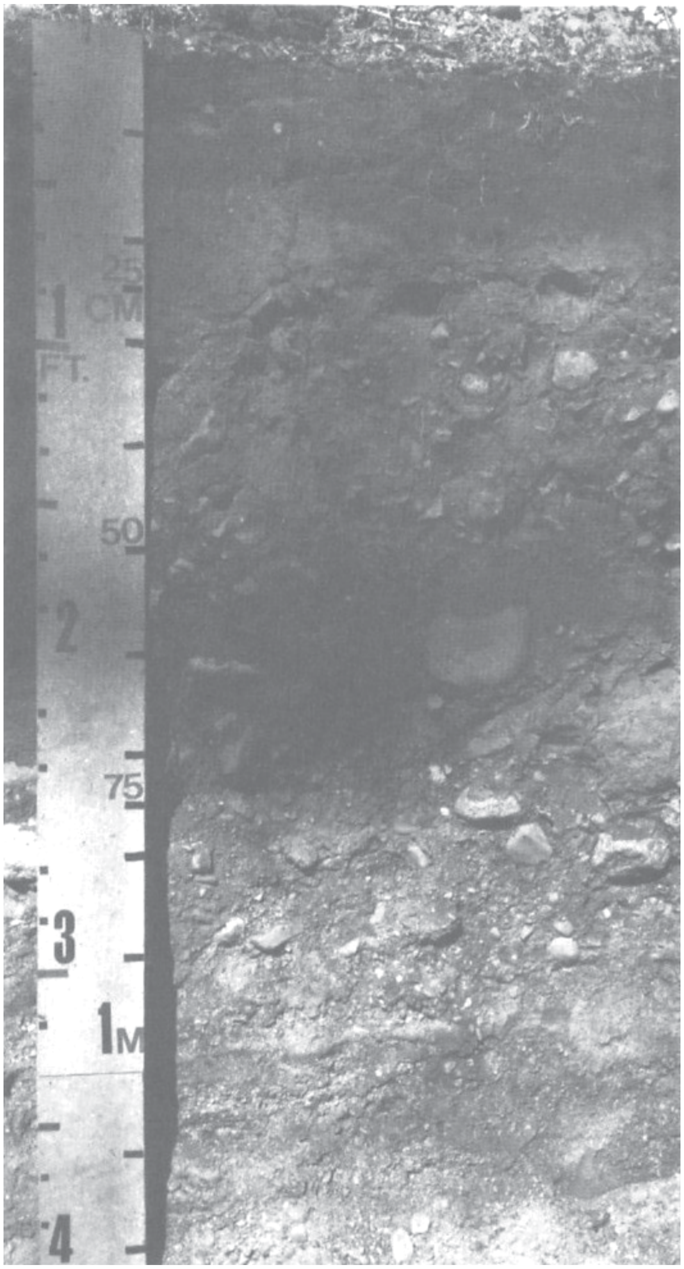

Figure 15.—Profile of Dorset sandy loam, 2 to 6 percent slopes.

carbonates range from 18 to 36 inches. The depth to loamy sand or coarser textured material ranges from 12 to 24 inches. The mollic epipedon is 6 to 10 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or fine sandy loam. The B and 2B horizons have hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. The B horizon is sandy loam or loam. The 2B horizon is gravelly loamy coarse sand, gravelly sand, or gravelly coarse sand. The 2C horizon has hue of 10YR or 7.5YR, value of 3 to 6, and chroma of 3 or 4. It is gravelly coarse sand or stratified coarse sand and gravel.

Duelm Series

The Duelm series consists of deep, somewhat poorly drained and moderately well drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in thick deposits of sandy outwash. Slopes range from 0 to 2 percent.

Typical pedon of Duelm loamy sand, 450 feet north and 100 feet west of the southeast corner of sec. 2, T. 131 N., R. 33 W.

A1—0 to 9 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; less than 2 percent coarse fragments; medium acid; clear wavy boundary.

A2—9 to 15 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; less than 2 percent coarse fragments; slightly acid; clear wavy boundary.

BA—15 to 24 inches; about 80 percent dark grayish brown (10YR 4/2) loamy sand and 20 percent very dark grayish brown (10YR 3/2) loamy sand; weak medium subangular blocky structure; very friable; less than 2 percent coarse fragments; medium acid; clear wavy boundary.

Bw—24 to 44 inches; grayish brown (10YR 5/2) coarse sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 3 percent coarse fragments; medium acid; clear wavy boundary.

C—44 to 60 inches; brown (10YR 5/3) coarse sand; common medium faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; single grained; loose; about 4 percent coarse fragments; medium acid.

The thickness of the solum ranges from 32 to 60 inches. The depth to free carbonates ranges from 50 to 100 inches. The mollic epipedon is 10 to 20 inches thick. The content of coarse fragments typically is less than 5 percent throughout the profile, but in some pedons it is as much as 15 percent. The fragments are mainly 2 to 5 millimeters in size.

The A horizon has value of 2 or 3 and chroma of 1 or

2. It is loamy coarse sand, loamy sand, sand, or coarse sand. Some pedons have an AB horizon, which is as much as 6 inches thick. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. It is mottled within a depth of 40 inches. It is coarse sand, sand, loamy sand, or loamy coarse sand. The individual sand grains in the C horizon commonly are multicolored. In some pedons the content of fine gravel in this horizon is as much as 15 percent.

Eckvoll Series

The Eckvoll series consists of deep, moderately well drained soils on till plains mantled with sandy material. These soils formed in 16 to 36 inches of sandy material and in the underlying loamy glacial till. Permeability is moderately rapid in the upper part of the profile and moderate in the underlying material. Slopes range from 1 to 3 percent.

Typical pedon of Eckvoll loamy sand, 2,310 feet north and 110 feet east of the southwest corner of sec. 16, T. 133 N., R. 32 W.

Ap—0 to 9 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

E—9 to 20 inches; brown (10YR 5/3) sand, light gray (10YR 7/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; single grained; loose; about 1 percent coarse fragments; slightly acid; gradual wavy boundary.

EB—20 to 27 inches; dark brown (10YR 4/3) sand; common medium faint dark yellowish brown (10YR 3/4) mottles; single grained; loose; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

2Bt—27 to 39 inches; yellowish brown (10YR 5/4) loam; mixed with dark brown (10YR 4/3) material; many medium distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 4/6) mottles; moderate fine subangular blocky structure; friable; many light gray (10YR 7/2) sand grains on faces of peds; about 3 percent coarse fragments; few distinct very dark grayish brown (10YR 3/2) clay films lining pores; slightly acid; clear wavy boundary.

2C—39 to 60 inches; yellowish brown (10YR 5/4) loam; common medium distinct light brownish gray (10YR 6/2) and yellowish brown (10YR 5/8) mottles; moderate thin platy structure; friable; about 2 percent coarse fragments; very few dark brown (10YR 3/3) clay films lining the major root channels; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 20 to 48 inches. The thickness of the sandy sediments ranges from 16 to 36 inches.

The A or Ap horizon has value of 2 or 3 and chroma of 1 to 3. It is loamy fine sand or loamy sand. The E horizon has value of 4 to 6 and chroma of 2 to 4. It is fine sand, sand, or loamy sand. The 2Bt horizon has hue of 2.5Y or 10YR, value of 3 to 6, and chroma of 2 to 4. It is loam, silty clay loam, or clay loam. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is loam, clay loam, or silt loam.

Flak Series

The Flak series consists of deep, well drained soils on drumlins and ground moraines. These soils formed in noncalcareous, loamy glacial till. Permeability is moderately rapid in the upper part of the profile and very slow in the lower part. Slopes range from 2 to 12 percent.

The Flak soils in Todd County have a thicker, darker surface layer than is definitive for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Flak sandy loam, 6 to 12 percent slopes, 400 feet west and 1,750 feet north of the southeast corner of sec. 15, T. 129 N., R. 32 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; friable; about 8 percent coarse fragments; strongly acid; abrupt smooth boundary.

E—8 to 14 inches; dark brown (10YR 4/3) sandy loam, pale brown (10YR 6/3) dry; weak medium platy structure; friable; about 10 percent coarse fragments; strongly acid; clear wavy boundary.

B/E—14 to 21 inches; dark brown (7.5YR 4/4 and 10YR 4/3) sandy loam; weak medium subangular blocky structure; friable; about 10 percent coarse fragments; few distinct dark brown (10YR 3/3) clay films on faces of peds; strongly acid; clear wavy boundary.

Bt—21 to 33 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; about 10 percent coarse fragments; common distinct dark brown (10YR 3/3) clay films on faces of peds; medium acid; clear wavy boundary.

Cd—33 to 60 inches; dark brown (7.5YR 4/4) dense till that crushes to sandy loam; weak thin platy structure; firm; about 10 percent coarse fragments; medium acid.

The solum ranges from 30 to 45 inches in thickness. The depth to dense till ranges from 20 to 40 inches. The content of coarse fragments is 10 to 20 percent throughout the profile. In some pedons it is as little as 2 percent in the A horizon. It generally is highest in the horizon directly below the E horizon or in the horizon directly above the dense till.

The A, E, and Bt horizons are sandy loam or fine sandy loam. The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 or 5 and chroma of 2 or 3. The Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. In some pedons mottles with high chroma are in the lower part of the B horizon. The Cd horizon has value of 4 or 5 and chroma of 3 to 5.

Flom Series

The Flom series consists of deep, poorly drained, moderately slowly permeable soils on moraines. These soils formed in loamy till. Slopes are 0 to 1 percent.

Typical pedon of Flom loam, 2,380 feet west and 300 feet north of the southeast corner of sec. 30, T. 127 N., R. 35 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

A—10 to 14 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

Bg—14 to 24 inches; grayish brown (2.5Y 5/2) loam; common fine distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

Cg1—24 to 30 inches; grayish brown (2.5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; about 4 percent coarse fragments; fine irregularly shaped light gray (2.5Y 7/2) accumulations of lime in seams; strong effervescence; mildly alkaline; clear wavy boundary.

Cg2—30 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct brownish yellow (10YR 6/8) and olive yellow (2.5Y 6/6) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; fine irregularly shaped light gray (2.5Y 7/2) accumulations of lime in seams; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 14 to 32 inches. The mollic epipedon ranges from 10 to 24 inches in thickness. The content of coarse fragments in the glacial till is 2 to 10 percent. The fragments are 2 millimeters to 3 inches in size.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. In some pedons it is mottled in the lower part. It is loam, silty clay loam, or clay loam. The B and C horizons are loam or clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is mottled in some or all parts. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It commonly is mottled throughout. The upper part of this horizon commonly has an accumulation of free carbonates.

Forada Series

The Forada series consists of deep, poorly drained soils on outwash plains. These soils formed in loamy alluvial sediments 22 to 40 inches deep over sand and gravel. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Forada sandy loam, 400 feet south and 1,025 feet east of the northwest corner of sec. 17, T. 132 N., R. 35 W.

A—0 to 12 inches; black (N 2/0) sandy loam, dark gray (10YR 4/1) dry; weak medium granular structure; friable; less than 2 percent coarse fragments; slightly acid; clear wavy boundary.

AB—12 to 18 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; less than 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bg1—18 to 22 inches; dark grayish brown (2.5Y 4/2) sandy loam; many fine prominent yellowish brown (10YR 5/8) mottles; weak fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; slightly acid; clear wavy boundary.

Bg2—22 to 26 inches; grayish brown (2.5Y 5/2) sandy loam; few fine prominent yellowish brown (10YR

5/8) mottles; weak fine subangular blocky structure; friable; about 6 percent coarse fragments; neutral; clear wavy boundary.

BC—26 to 33 inches; dark grayish brown (2.5Y 4/2) loamy sand; common medium prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; about 6 percent coarse fragments; neutral; clear wavy boundary.

2C1—33 to 46 inches; dark grayish brown (2.5Y 4/2) coarse sand; common fine distinct olive brown (2.5Y 4/4) mottles; single grained; loose; about 10 percent coarse fragments; mildly alkaline; clear wavy boundary.

2C2—46 to 60 inches; light brownish gray (2.5Y 6/2) coarse sand; common fine distinct olive brown (2.5Y 4/4) mottles; single grained; loose; about 5 percent coarse fragments; mildly alkaline.

The thickness of the solum, the depth to free carbonates, and the depth to loamy sand or coarser textured material range from 22 to 40 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches. The content of coarse fragments ranges from 0 to 10 percent in the alluvial sediments and from 0 to 35 percent in the 2C horizon. Most of the fragments are 2 to 5 millimeters in size.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 or 3 and chroma of 0. It is loam or sandy loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It commonly is mottled. It is loam, sandy loam, or loamy sand. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It is sand, coarse sand, or gravelly coarse sand.

Gonvick Series

The Gonvick series consists of deep, moderately well drained, moderately permeable soils on moraines. These soils formed in calcareous, loamy glacial till. Slopes range from 1 to 3 percent.

Typical pedon of Gonvick loam, 1,950 feet west and 400 feet south of the northeast corner of sec. 1, T. 127 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; very friable; about 4 percent coarse fragments; neutral; abrupt smooth boundary.

A—9 to 12 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; very friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bt1—12 to 18 inches; dark brown (10YR 4/3) loam; few fine faint dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; friable; common clean silt particles and sand grains on faces of some peds; about 3 percent coarse fragments; common faint very dark grayish brown (10YR 3/2) clay films on faces of peds; slightly acid; clear wavy boundary.

Bt2—18 to 26 inches; dark brown (10YR 4/3) loam; common fine faint dark grayish brown (2.5Y 4/2) mottles; moderate medium subangular blocky structure; firm; about 5 percent coarse fragments; many distinct very dark grayish brown (10YR 3/2) clay films on faces of peds and lining tubular pores; slightly acid; clear wavy boundary.

Bt3—26 to 32 inches; dark grayish brown (2.5Y 4/2) loam; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; firm; about 6 percent coarse fragments; common distinct very dark brown (10YR 2/2) clay films on faces of peds and lining tubular pores; neutral; clear wavy boundary.

C—32 to 60 inches; light olive brown (2.5Y 5/4) loam; common fine distinct dark grayish brown (2.5Y 4/2) mottles; massive breaking to weak thin platy soil fragments; friable; about 4 percent coarse fragments; fine irregularly shaped light gray (10YR 7/1) accumulations of lime in seams; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 22 to 38 inches. The mollic epipedon is 8 to 16 inches thick. The content of coarse fragments is 2 to 8 percent throughout the profile. The fragments are 2 millimeters to 3 inches in size. The soils are loam or clay loam throughout.

The Ap and A horizons have value of 2 or 3. Some pedons have an E horizon. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It has few to many mottles. It has faint to prominent clay films. The C horizon has value of 5 or 6 and chroma of 2 to 4. It commonly is mottled.

Hangaard Series

The Hangaard series consists of deep, poorly drained, rapidly permeable soils on outwash plains and stream terraces. These soils formed in a thin mantle of loamy sediments over sand and gravel. Slopes are 0 to 1 percent.

Typical pedon of Hangaard sandy loam, 2,200 feet east and 200 feet south of the northwest corner of sec. 5, T. 132 N., R. 35 W.

Ap—0 to 10 inches; black (N 2/0) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common very fine and fine roots; about 3 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.

BA—10 to 14 inches; about 70 percent very dark grayish brown (2.5Y 3/2) sandy loam and 30 percent black (N 2/0) sandy loam; common fine prominent strong brown (7.5YR 5/6) mottles; weak fine granular structure; friable; common very fine roots; about 8 percent coarse fragments; neutral; clear wavy boundary.

2Bg—14 to 18 inches; dark grayish brown (2.5Y 4/2) loamy sand; common medium prominent brown (7.5YR 5/4) mottles and concretions; weak fine subangular blocky structure; very friable; few very fine roots; about 14 percent coarse fragments; neutral; clear wavy boundary.

2C1—18 to 36 inches; strong brown (7.5YR 5/6) gravelly coarse sand; common medium prominent grayish brown (2.5Y 5/2) mottles; single grained; loose; about 20 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

2C2—36 to 60 inches; about 70 percent light brownish gray (2.5Y 6/2) sand and 30 percent light yellowish brown (10YR 5/6) sand; common medium faint grayish brown (2.5Y 5/2) mottles; single grained; loose; about 10 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to loamy sand or coarser textured material range from 7 to 20 inches. The mollic epipedon is 7 to 18 inches thick. The depth to free carbonates ranges from 0 to 24 inches. The content of coarse fragments ranges from 10 to 35 percent in the control section. The fragments are mostly of gravel size.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 and chroma of 0. It generally is mottled in the lower part. It typically is sandy loam, but the range includes loam, loamy sand, and coarse sandy loam. The 2Bg horizon has chroma of 1 or 2. It is loamy sand or loamy coarse sand. The 2C horizon has hue of 5Y to 7.5YR, value of 5 or 6, and chroma of 3 or less. It has distinct or prominent mottles. It is stratified sand or coarse sand that has gravelly layers.

Holdingford Series

The Holdingford series consists of deep, well drained, moderately permeable soils on ground moraines and drumlins. These soils formed in noncalcareous, loamy glacial till over calcareous, loamy till. Slopes range from 2 to 12 percent.

Typical pedon of Holdingford sandy loam, 2 to 6 percent slopes, 2,600 feet north and 330 feet west of the southeast corner of sec. 1, T. 128 N., R. 33 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to weak fine granular; friable; about 8 percent coarse fragments; medium acid; clear wavy boundary.

E—6 to 13 inches; dark brown (10YR 4/3) sandy loam, very pale brown (10YR 7/3) dry; moderate thin platy structure; friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

E/B—13 to 18 inches; grayish brown (10YR 5/2) and dark reddish gray (5YR 4/2) sandy loam (E); moderate fine subangular blocky structure; friable; about 15 percent dark brown (10YR 4/3) sandy loam (Bt); about 8 percent coarse fragments; slightly acid; clear wavy boundary.

Bt1—18 to 29 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; firm; about 6 percent coarse fragments; common distinct dark brown (7.5YR 3/2) clay films on faces of peds and lining tubular pores; slightly acid; clear wavy boundary.

Bt2—29 to 38 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; firm; about 5 percent coarse fragments; many faint dark brown (7.5YR 3/2) clay films on faces of peds; strongly acid; clear wavy boundary.

Bt3—38 to 47 inches; dark brown (7.5YR 4/4) and yellowish brown (10YR 5/6) sandy loam; moderate medium subangular blocky structure; firm; about 6 percent coarse fragments; many distinct dark brown (7.5YR 3/2) clay films on faces of peds and lining tubular pores; medium acid; clear wavy boundary.

2C—47 to 60 inches; yellowish brown (10YR 5/4) sandy loam; common fine faint yellowish brown (10YR 5/6) mottles; massive breaking to moderate thin platy soil fragments; firm; about 2 percent coarse fragments; fine irregularly shaped light gray (10YR 7/2) filaments of lime; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 26 to 60 inches. The content of coarse fragments ranges from 2 to 20 percent throughout the profile. Most of the fragments range from 2 millimeters to 3 inches in size.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is sandy loam or fine sandy loam. The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. It is dominantly sandy loam, but fine sandy loam and loamy sand are within the range. The Bt horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 or 4. In some pedons it has faint or distinct mottles with high chroma. It is commonly sandy loam or fine sandy loam, but in some pedons it has subhorizons of loam. The C horizon has value of 4 to 6 and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam. In most pedons it has fine, soft threads or masses of lime.

Hubbard Series

The Hubbard series consists of deep, excessively drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in thick deposits of sandy material. Slopes range from 0 to 6 percent.

Typical pedon of Hubbard loamy sand, 2 to 6 percent slopes, 450 feet north and 350 feet west of the southeast corner of sec. 2, T. 131 N., R. 33 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy sand, dark brown (10YR 3/3) dry; weak fine granular structure; very friable; strongly acid; clear wavy boundary.

AB—8 to 15 inches; very dark grayish brown (10YR 3/2) loamy sand, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; very friable; strongly acid; clear wavy boundary.

Bw1—15 to 24 inches; dark brown (7.5YR 4/4) sand; single grained; loose; medium acid; clear wavy boundary.

Bw2—24 to 30 inches; dark brown (7.5YR 4/4) sand; single grained; loose; medium acid; clear wavy boundary.

C—30 to 60 inches; yellowish brown (10YR 5/4) sand; single grained; loose; about 5 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 25 to 50 inches. The depth to free carbonates ranges from 50 to 80 inches. The mollic epipedon ranges from 10 to 22 inches in thickness. The content of coarse fragments is 0 to 10 percent throughout the profile.

The A and B horizons are coarse sand, sand, loamy coarse sand, or loamy sand. The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 5. It is coarse sand or sand.

Huntersville Series

The Huntersville series consists of deep, moderately well drained soils on uplands and drumlins mantled with sandy material. These soils formed in sandy material 20 to 40 inches deep over dense, loamy glacial till. Permeability is rapid in the upper part of the profile and very slow in the lower part. Slopes range from 1 to 4 percent.

Typical pedon of Huntersville loamy sand, 1 to 4 percent slopes, 1,310 feet east and 175 feet north of the center of sec. 18, T. 131 N., R. 32 W.

A—0 to 6 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) loamy sand; weak fine granular structure; very friable; about 1 percent coarse fragments; strongly acid; clear wavy boundary.

E1—6 to 14 inches; dark brown (10YR 4/3) loamy sand; weak very thin platy structure; very friable; many brown (10YR 5/3) streaks; about 5 percent coarse fragments; strongly acid; clear wavy boundary.

E2—14 to 27 inches; dark brown (10YR 4/3) sand; few fine distinct yellowish brown (10YR 5/6) mottles; moderate thick platy structure; friable; many pale brown (10YR 6/3) sand grains on faces of peds; about 7 percent coarse fragments; medium acid; gradual wavy boundary.

2BE—27 to 33 inches; dark yellowish brown (10YR 4/4) sandy loam; few fine prominent strong brown (7.5YR 5/6) mottles; moderate thin platy structure; friable; many pale brown (10YR 6/3) sand grains on faces of peds; about 7 percent coarse fragments; medium acid; clear wavy boundary.

2Bt—33 to 53 inches; yellowish brown (10YR 5/6) sandy loam; many medium distinct grayish brown (10YR 5/2) mottles; moderate thin platy structure; friable; about 5 percent coarse fragments; common dark brown (10YR 3/3) clay films on faces of peds; many very dark grayish brown (10YR 3/2) clay films in pores; slightly acid; clear wavy boundary.

2Cd—53 to 60 inches; yellowish brown (10YR 5/4) dense till that crushes to sandy loam; many medium distinct strong brown (7.5YR 4/6) mottles; moderate thick platy soil fragments; friable; few dark brown (10YR 3/3) clay films in pores; about 5 percent coarse fragments; many light gray (10YR 7/2) coatings of carbonate in internal planes; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 48 to 60 inches. The sandy mantle ranges from 20 to 40 inches in thickness. The content of coarse fragments ranges from 0 to 15 percent throughout the profile. In some pedons a stone line as much as 12 inches thick is at the contact point of the sandy and loamy sediments.

The Ap or A horizon and the E horizon are loamy sand, fine sand, sand, or loamy fine sand. The Ap or A horizon has value of 2 or 3 and chroma of 1 to 3. The E horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. In some pedons it is mottled. Most pedons have an EB, BE, B/E, or E/B horizon. This horizon is sand, loamy sand, or the gravelly or cobbly analogs of these textures. It is mottled in some pedons. The 2Bt horizon has hue of 10YR or 2.5Y and value and chroma of 4 to 6. It has faint to prominent clay films. The 2Cd horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2 to 4. It is mottled in some pedons.

Isan Series

The Isan series consists of deep, poorly drained and very poorly drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in thick deposits of sandy material. Slopes are less than 1 percent.

Typical pedon of Isan loamy sand, 750 feet north and 100 feet west of the southeast corner of sec. 2, T. 131 N., R. 33 W.

A1—0 to 14 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; medium acid; clear wavy boundary.

A2—14 to 19 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; medium acid; clear wavy boundary.

Bg—19 to 27 inches; dark gray (10YR 4/1) loamy sand; few fine prominent strong brown (7.5YR 5/6) mottles; weak fine and medium subangular blocky structure; very friable; medium acid; clear wavy boundary.

Cg—27 to 60 inches; grayish brown (2.5Y 5/2) sand; few fine prominent strong brown (7.5YR 5/6) mottles; single grained; loose; medium acid.

The thickness of the solum ranges from 15 to 30 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is typically loamy sand but ranges from sandy loam to loamy coarse sand. The B horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2. It has few to many, distinct or prominent mottles. It is sand, coarse sand, loamy sand, or loamy coarse sand. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is sand or coarse sand.

Kandota Series

The Kandota series consists of deep, well drained, moderately slowly permeable soils on ground moraines and uplands. These soils formed in loamy glacial till. Slopes range from 2 to 25 percent.

Typical pedon of Kandota sandy loam, 2 to 6 percent slopes, 1,130 feet north and 800 feet east of the center of sec. 20, T. 131 N., R. 35 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; friable; many fine roots; about 3 percent coarse fragments; strongly acid; abrupt smooth boundary.

E—6 to 16 inches; yellowish brown (10YR 5/4) sandy loam, pale brown (10YR 6/3) dry; weak medium platy structure parting to weak fine subangular blocky; friable; common fine roots; about 5 percent coarse fragments; strongly acid; abrupt smooth boundary.

BE—16 to 26 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few fine roots; common distinct dark yellowish brown (10YR 3/4) organic coatings on faces of peds; many pale brown (10YR 6/3) sand grains on faces of peds; about 2 percent coarse fragments; strongly acid; clear smooth boundary.

Bt—26 to 33 inches; dark yellowish brown (10YR 4/6) sandy clay loam; moderate medium prismatic structure parting to strong medium subangular blocky; firm; very few fine roots; about 5 percent coarse fragments; many distinct dark brown (10YR 3/3) clay films on faces of peds; medium acid; clear wavy boundary.

BC—33 to 40 inches; yellowish brown (10YR 5/4) sandy loam; weak thin platy structure; very few fine roots; about 5 percent coarse fragments; many distinct dark brown (10YR 3/3) clay films on faces of peds; few very pale brown (10YR 7/3) coatings of carbonate on faces of peds; strong effervescence; mildly alkaline; gradual smooth boundary.

C1—40 to 51 inches; light yellowish brown (10YR 6/4) sandy loam; weak thin platy soil fragments; firm; few very pale brown (10YR 7/3) filaments of carbonate; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—51 to 60 inches; yellowish brown (10YR 5/4) sandy loam; weak thin platy soil fragments; firm; few very pale brown (10YR 7/3) filaments of carbonate; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 50 inches. The content of coarse fragments ranges from 2 to 25 percent throughout the profile. Most of the fragments range from 2 millimeters to 3 inches in size. The dark surface layer is 5 to 10 inches thick.

The A and E horizons are dominantly sandy loam, but fine sandy loam is within the range. The A horizon has value of 2 or 3 and chroma of 1 to 3. The E horizon has value of 4 to 6 and chroma of 2 to 4. Most pedons have an EB or BE horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 6. It is sandy clay loam or sandy loam in which the content of clay ranges from 18 to 30 percent. This horizon has few to many, faint to prominent clay films. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 to 6.

Langhei Series

The Langhei series consists of deep, well drained, moderately permeable soils on ground moraines. These soils formed in calcareous, loamy glacial till. Slopes range from 4 to 25 percent.

Typical pedon of Langhei loam, in an area of Waukon-Langhei loams, 12 to 25 percent slopes; 2,300 feet south and 2,600 feet east of the northwest corner of sec. 19, T. 127 N., R. 35 W.

Ap—0 to 10 inches; mixed very dark grayish brown (2.5Y 3/2) and dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium and fine subangular blocky structure; friable; about 8 percent coarse fragments; few fine irregularly shaped light gray (10YR 7/2) masses of lime in seams; strong effervescence; mildly alkaline; abrupt smooth boundary.

C—10 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; about 6 percent coarse fragments; common fine irregularly shaped light gray (10YR 7/1) masses of lime in seams; strong effervescence; mildly alkaline.

The content of coarse fragments is 2 to 10 percent throughout the profile. Most of the fragments range from 2 to 10 millimeters in size.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. It typically is loam but in some pedons is clay loam. The C horizon has value of 4 to 7 and chroma of 2 to 4. It has few to many, faint or distinct, relict mottles in some pedons. It is dominantly loam, but in some pedons it has subhorizons of clay loam. Some pedons have an accumulation of carbonates in the upper part of the C horizon.

Lowlein Series

The Lowlein series consists of deep, moderately well drained soils on moraines. These soils formed in stratified material 24 to 40 inches deep over calcareous, loamy glacial till. Permeability is moderately rapid or rapid in the solum and moderate in the underlying material. Slopes range from 1 to 4 percent.

The Lowlein soils in Todd County formed under a colder climate than is typical for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Lowlein sandy loam, 1,750 feet south and 420 feet west of the northeast corner of sec. 28, T. 128 N., R. 35 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; about 1 percent coarse fragments; slightly acid; abrupt smooth boundary.

A—10 to 15 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; slightly acid; clear wavy boundary.

Bw1—15 to 20 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

Bw2—20 to 31 inches; dark yellowish brown (10YR 4/4) sandy loam; common medium distinct grayish brown (10YR 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

2C—31 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; common fine light gray (10YR 7/2) irregularly shaped filaments or threads of lime; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 40 inches. The mollic epipedon is 10 to 18 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or loam. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The hue of 2.5Y is typically in the lower part. This horizon is sandy loam, loamy sand, or sand in the lower part. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 4.

Mahtomedi Series

The Mahtomedi series consists of deep, excessively drained, rapidly permeable soils on outwash plains and ground moraines. These soils formed in sandy outwash. Slopes range from 1 to 45 percent.

Typical pedon of Mahtomedi loamy sand, in an area of Cushing-DeMontreville-Mahtomedi complex, 15 to 45 percent slopes; 1,120 feet south and 480 feet east of the northwest corner of sec. 12, T. 131 N., R. 32 W.

A—0 to 5 inches; very dark brown (10YR 2/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; about 3 percent coarse fragments; medium acid; clear wavy boundary.

E—5 to 18 inches; dark brown (10YR 4/3) sand, pale brown (10YR 6/3) dry; single grained; loose; about 8 percent coarse fragments; medium acid; gradual wavy boundary.

Bw—18 to 30 inches; dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) gravelly coarse sand; single grained; loose; about 17 percent coarse fragments; slightly acid; gradual wavy boundary.

C—30 to 60 inches; stratified dark brown (7.5YR 4/4) sand and brown (7.5YR 5/4) gravelly coarse sand; single grained; loose; about 15 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 20 to 40 inches. The C horizon has a small amount of free carbonates in some pedons. The content of coarse fragments in the control section generally ranges from 10 to 35 percent, but in some pedons it is less than 10 or more than 35 percent. Most of the fragments range from 2 millimeters to 5 centimeters in size.

The A and E horizons are loamy coarse sand, loamy sand, sand, or coarse sand. The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 1 to 3.

The B horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 4 to 6. It is coarse sand, sand, or the gravelly analogs of these textures. Some pedons have a BE or BC horizon.

The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 or 4. It typically is gravelly coarse sand, but in some pedons it has subhorizons of finer or coarser textured material.

Markey Series

The Markey series consists of deep, very poorly drained soils on outwash plains and till plains. These soils formed in herbaceous organic material 16 to 51 inches deep over sandy outwash sediments. Permeability is moderately rapid in the organic material and rapid in the sandy underlying material. Slopes are less than 1 percent.

Typical pedon of Markey muck, 600 feet east and 150 feet north of the southwest corner of sec. 36, T. 133 N., R. 33 W.

Oa1—0 to 12 inches; sapric material, black (10YR 2/1) broken face and rubbed, very dark brown (10YR 2/2) pressed; about 90 percent fiber unrubbed, less than 10 percent rubbed; weak fine granular structure; very friable; medium acid; clear wavy boundary.

Oa2—12 to 22 inches; sapric material, very dark brown (10YR 2/2) broken face and rubbed, very dark gray (10YR 3/1) pressed; about 80 percent fiber unrubbed, less than 10 percent rubbed; weak medium platy structure parting to weak fine subangular blocky; very friable; medium acid; clear wavy boundary.

Oa3—22 to 38 inches; sapric material, very dark gray (10YR 3/1) broken face and rubbed, very dark grayish brown (10YR 3/2) pressed; about 50 percent fiber unrubbed, less than 10 percent rubbed; weak medium platy structure; friable; medium acid; abrupt wavy boundary.

C—38 to 60 inches; dark gray (10YR 4/1) and very dark gray (10YR 3/1) sand; single grained; loose; slightly acid.

The depth to sand and gravel ranges from 16 to 50 inches. The organic part of the control section has hue of 7.5YR or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 3. The surface tier is hemic or sapric material that has a fiber content of 5 to 90 percent before rubbing and less than 20 percent after rubbing. The subsurface tier is typically sapric material, but it has less than 10 inches of hemic material. The content of fiber in this tier ranges from less than 5 percent to 80 percent before rubbing and is less than 10 percent after rubbing.

The C horizon generally has hue of 10YR to 2.5Y, value of 4 to 6, and chroma of 1 or 2. In some pedons, however, it has a thin layer of black (10YR 2/1) or very dark brown (10YR 2/2) material. This horizon is dominantly sand or gravelly sand, but in some pedons it is sandy loam or loamy sand in the upper 10 inches.

Meehan Series

The Meehan series consists of deep, somewhat poorly drained, rapidly permeable soils on outwash plains and stream terraces. These soils formed in thick deposits of sandy outwash. Slopes range from 0 to 2 percent.

Typical pedon of Meehan loamy sand, 900 feet north and 2,000 feet west of the southeast corner of sec. 19, T. 133 N., R. 32 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; neutral; clear smooth boundary.

Bw1—8 to 14 inches; about 75 percent dark yellowish brown (10YR 4/4) sand and 25 percent brown (10YR 5/3) sand; single grained; loose; neutral; clear smooth boundary.

Bw2—14 to 28 inches; about 80 percent brown (10YR 5/3) coarse sand and 20 percent yellowish brown (10YR 5/6) and yellowish red (5YR 4/8) bands of bog iron; many coarse distinct light brownish gray (10YR 6/2) mottles; single grained; loose; neutral; clear wavy boundary.

Bw3—28 to 35 inches; brown (10YR 5/3) coarse sand that has yellowish red (5YR 4/8) and dark reddish brown (5YR 2/2) bands of bog iron; many medium distinct light gray (10YR 7/1) mottles; single grained; loose; neutral; clear wavy boundary.

C1—35 to 46 inches; dark yellowish brown (10YR 4/4) sand that has strong brown (7.5YR 5/8) bands of bog iron; single grained; loose; neutral; clear wavy boundary.

C2—46 to 60 inches; about 70 percent pale brown (10YR 6/3) sand and 30 percent yellowish brown (10YR 5/6) sand; single grained; loose; neutral.

The thickness of the solum ranges from 24 to 48 inches. The depth to free carbonates ranges from 50 to 100 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loamy sand or sand. Some pedons have an E horizon. This horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3. It is mottled in a few pedons. It is loamy sand or sand.

The B horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 6. It has mottles with chroma of 1 or 2 within a depth of 40 inches. It is coarse sand, sand, loamy sand, or loamy coarse sand.

The C horizon has hue of 10YR or 7.5YR, value of 4 to 7, and chroma of 2 to 4. It has strata with high chroma or has few or common mottles. It is sand or coarse sand. In some pedons the content of fine gravel in this horizon is as much as 5 percent.

Menahga Series

The Menahga series consists of deep, excessively drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in sandy glacial outwash. Slopes range from 2 to 25 percent.

Typical pedon of Menahga loamy sand, 2 to 6 percent slopes, 100 feet north and 2,625 feet west of the southeast corner of sec. 19, T. 133 N., R. 32 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; medium acid; abrupt smooth boundary.

Bw1—3 to 20 inches; yellowish brown (10YR 5/6) sand; single grained; loose; medium acid; clear wavy boundary.

Bw2—20 to 29 inches; dark yellowish brown (10YR 4/6) sand; single grained; loose; medium acid; clear wavy boundary.

C—29 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; slightly acid.

The thickness of the solum ranges from 20 to 46 inches. Typically, these soils have no coarse fragments, but in some pedons the content of gravel is as much as 15 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Some pedons have an E horizon. This horizon typically is loamy sand, but the range includes sand, coarse sand, and loamy coarse sand. The B and C horizons are coarse sand or sand. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. The C horizon has hue of 10YR or 7.5YR, value of

5 or 6, and chroma of 3 to 5. In some pedons it is stratified.

Nokay Series

The Nokay series consists of deep, somewhat poorly drained soils on drumlins and ground moraines. These soils formed in noncalcareous, loamy glacial till. Permeability is moderate or moderately rapid in the upper part of the profile and very slow in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Nokay sandy loam, in an area of Prebish-Nokay sandy loams; 1,920 feet west and 40 feet south of the northeast corner of sec. 31, T. 129 N., R. 32 W.

A—0 to 5 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; many fine roots; about 2 percent coarse fragments; strongly acid; gradual wavy boundary.

E1—5 to 11 inches; grayish brown (10YR 5/2) sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak thin platy structure; friable; common medium roots; about 2 percent coarse fragments; strongly acid; gradual wavy boundary.

E2—11 to 18 inches; grayish brown (10YR 5/2) sandy loam; many medium distinct yellowish brown (10YR 5/8) mottles; moderate thin platy structure; friable; common fine roots; about 2 percent coarse fragments; strongly acid; gradual wavy boundary.

Bt1—18 to 28 inches; strong brown (7.5YR 5/6) sandy loam; many medium prominent grayish brown (10YR 5/2) mottles; weak thin platy structure; friable; about 2 percent coarse fragments; few faint yellowish red (5YR 4/6) clay films on faces of peds; few fine roots; strongly acid; gradual wavy boundary.

Bt2—28 to 43 inches; brown (7.5YR 5/4) sandy loam; many medium distinct light gray or gray (10YR 6/1) mottles; moderate thin platy structure; firm; about 2 percent coarse fragments; few distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; few fine roots; strongly acid; clear wavy boundary.

BC—43 to 60 inches; brown (7.5YR 5/4) sandy loam; many medium distinct dark yellowish brown (10YR 4/4) mottles; moderate thin platy structure; firm; about 2 percent coarse fragments; few distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid.

The thickness of the solum ranges from 38 to 60 inches. The depth to dense till ranges from 22 to 40 inches. The content of coarse fragments ranges from 2 to 15 percent throughout the profile. Most of the fragments range from 2 millimeters to 4 inches in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, fine sandy loam, or loam. The E horizon has value of 4 or 5 and chroma of 1 or 2. It has faint to prominent mottles. It is sandy loam or fine sandy loam.

The B horizon has value of 4 or 5 and chroma of 2 to 6. It has faint or distinct mottles. It is fine sandy loam, sandy loam, or loam. It has thin or medium, patchy or continuous clay films on faces of peds and in pores and root channels.

The BC horizon and the Cd horizon, if it occurs, have value of 4 or 5 and chroma of 3 to 5. Faint to prominent mottles are in the BC horizon and in the upper part of the Cd horizon. These horizons are sandy loam or fine sandy loam.

Normania Series

The Normania series consists of deep, moderately well drained, moderately permeable soils on ground moraines and till plains. These soils formed in calcareous, loamy glacial till. Slopes range from 0 to 4 percent.

The Normania soils in Todd County formed under a colder climate than is typical for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Normania loam, 600 feet north and 2,540 feet west of the southeast corner of sec. 30, T. 127 N., R. 35 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; very friable; about 3 percent coarse fragments; slightly acid; clear smooth boundary.

A—8 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; very friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

Bw1—12 to 20 inches; dark grayish brown (2.5Y 4/2) loam; moderate medium and fine subangular blocky structure; very friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

Bw2—20 to 29 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct olive yellow (2.5Y 6/6) mottles; moderate fine subangular blocky structure; very friable; about 6 percent coarse fragments;

neutral; abrupt smooth boundary.

Bk—29 to 39 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; very friable; about 8 percent coarse fragments; many fine irregularly shaped light gray (10YR 7/2) filaments of lime; strong effervescence; mildly alkaline; clear smooth boundary.

C1—39 to 52 inches; light yellowish brown (2.5Y 6/4) loam; common fine distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/8) mottles; weak thin platy structure; friable; about 8 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

C2—52 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/8) mottles; weak thin platy structure; friable; about 8 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 18 to 40 inches in thickness. The depth to free carbonates ranges from 18 to 30 inches. The mollic epipedon is 10 to 16 inches thick. The content of coarse fragments is 3 to 8 percent throughout the profile. Most of the fragments are 2 to 5 millimeters in size. The soils are loam or clay loam throughout.

The A and Ap horizons have value of 2 or 3. The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. It has many faint to prominent mottles. The Bk horizon has value of 4 or 5 and chroma of 2 to 4. It qualifies as a calcic horizon in most pedons. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 4. It has few to many, faint to prominent mottles.

Nymore Series

The Nymore series consists of deep, excessively drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in sandy outwash. Slopes range from 1 to 12 percent.

Typical pedon of Nymore loamy sand, 1 to 6 percent slopes, 740 feet north and 320 feet east of the southwest corner of sec. 34, T. 129 N., R. 32 W.

Ap—0 to 6 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

AB—6 to 9 inches; dark brown (10YR 3/3) loamy sand, brown (10YR 5/3) dry; single grained; loose; slightly acid; clear smooth boundary.

Bw—9 to 23 inches; dark yellowish brown (10YR 4/4) sand; single grained; loose; medium acid; clear wavy boundary.

BC—23 to 29 inches; yellowish brown (10YR 5/6) sand; single grained; loose; medium acid; clear wavy boundary.

C—29 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; medium acid.

The thickness of the solum ranges from 24 to 45 inches. The depth to free carbonates ranges from 4 to more than 10 feet. The content of gravel is as much as 10 percent in the 10- to 40-inch control section.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is loamy sand, sand, coarse sand, or loamy coarse sand. The B horizon has hue of 10YR, 7.5YR, or 5YR and value and chroma of 3 to 6. The higher values and chromas are in the lower part. This horizon is dominantly sand or coarse sand, but in some pedons the upper part is loamy sand or loamy coarse sand. The C horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 2 to 4. It is sand or coarse sand.

Osakis Series

The Osakis series consists of deep, moderately well drained soils on outwash plains. These soils formed in loamy glacial alluvium 12 to 20 inches deep over outwash of sand and gravel. Permeability is moderate or moderately rapid in the upper part of the profile and rapid in the underlying material. Slopes range from 0 to 3 percent.

Typical pedon of Osakis sandy loam, 1,000 feet east and 800 feet south of the northwest corner of sec. 20, T. 132 N., R. 35 W.

Ap—0 to 13 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; about 3 percent coarse fragments; slightly acid; abrupt smooth boundary.

Bw—13 to 17 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; about 4 percent coarse fragments; slightly acid; abrupt smooth boundary.

2Bw—17 to 23 inches; very dark grayish brown (10YR 3/2) gravelly loamy sand; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium granular structure; friable; about 20 percent coarse fragments; neutral; abrupt smooth boundary.

2C1—23 to 32 inches; light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) gravelly coarse sand; few fine faint dark grayish brown (10YR 4/2) mottles; single grained; loose; about 30 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

2C2—32 to 60 inches; light brownish gray (10YR 6/2) gravelly coarse sand; few fine faint dark grayish brown (10YR 4/2) mottles; single grained; loose; about 25 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates are 16 to 25 inches. The depth to loamy sand or coarser textured material is 12 to 20 inches. The mollic epipedon is 12 to 16 inches thick. The content of coarse fragments ranges from 0 to 10 percent in the loamy mantle and from 10 to 70 percent in the underlying outwash.

The A and B horizons are sandy loam or loam. The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. It is mottled in some pedons. The 2B horizon has hue of 10YR or 2.5Y and value of 3 to 5. It is loamy sand, sand, loamy coarse sand, coarse sand, or the gravelly analogs of these textures. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. It has few to many mottles. It is sand, coarse sand, or the gravelly analogs of these textures.

Paddock Series

The Paddock series consists of deep, somewhat poorly drained soils on drumlins and ground moraines. These soils formed in loamy glacial till of the Wadena Lobe of the late Wisconsin Glaciation. Permeability is moderate in the upper part of the profile and very slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Paddock sandy loam, 800 feet west and 100 feet north of the southeast corner of sec. 6, T. 132 N., R. 34 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; common fine roots; about 2 percent coarse fragments; neutral; clear wavy boundary.

E—9 to 15 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; common fine distinct yellowish brown (10YR 5/4) and common fine faint grayish brown (10YR 5/2) mottles; weak thin platy structure; very friable; common fine roots; about 10 percent coarse fragments; neutral; clear wavy boundary.

BE—15 to 22 inches; grayish brown (10YR 5/2) sandy loam; common medium distinct yellowish brown (10YR 5/6) and few fine distinct very dark grayish brown (10YR 3/2) mottles; weak fine subangular blocky structure; friable; few fine roots; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

Bt1—22 to 32 inches; dark yellowish brown (10YR 4/4) and dark grayish brown (10YR 4/2) sandy loam; many coarse distinct grayish brown (2.5Y 5/2) and common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine roots; about 4 percent coarse fragments; common distinct very dark brown (10YR 2/2) clay films in pores; slightly acid; gradual wavy boundary.

Bt2—32 to 43 inches; dark yellowish brown (10YR 4/4) and dark grayish brown (10YR 4/2) sandy loam; few fine distinct dark brown (7.5YR 4/4) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; about 4 percent coarse fragments; many distinct very dark brown (10YR 2/2) clay films on faces of peds and in pores; neutral; gradual wavy boundary.

Cd1—43 to 56 inches; light olive brown (2.5Y 5/4) sandy loam; few fine distinct grayish brown (2.5Y 5/2) mottles; moderate thin platy soil fragments; friable; about 8 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Cd2—56 to 60 inches; light olive brown (2.5Y 5/4) sandy loam; common medium distinct grayish brown (2.5Y 5/2) mottles; moderate thin platy soil fragments; friable; about 14 percent coarse fragments; common light brownish gray (2.5Y 6/2) coatings of carbonate in channels; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 27 to 53 inches. The content of coarse fragments ranges from 2 to 15 percent throughout the profile. Most of the fragments range from 2 millimeters to 8 inches in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It typically is sandy loam, but fine sandy loam and loam are within the range. The E horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It has faint to prominent mottles. It is sandy loam or fine sandy loam. Some pedons have a B/E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It has common or many, distinct or prominent mottles. The Cd horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It has few or common mottles.

Prebish Series

The Prebish series consists of deep, very poorly drained, moderately slowly permeable soils in depressions on till plains and moraines. These soils formed in noncalcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Prebish fine sandy loam, 2,600 feet north and 1,250 feet west of the southeast corner of sec. 1, T. 128 N., R. 33 W.

A—0 to 12 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; common medium distinct gray (10YR 5/1) and common fine distinct dark brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

AB—12 to 17 inches; very dark gray (10YR 3/1) sandy loam; common medium distinct dark brown (7.5YR 4/4) and few fine faint gray (10YR 5/1) mottles; moderate fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

Bg—17 to 45 inches; gray (5Y 5/1) sandy loam; few fine prominent dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

2C—45 to 60 inches; dark brown (7.5YR 4/4) sandy loam; few fine faint dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; firm; about 8 percent coarse fragments; neutral.

The thickness of the solum ranges from 40 to 60 inches. In some pedons the C horizon has a small amount of free carbonates. The content of coarse fragments is 2 to 8 percent in the solum and 5 to 15 percent in the C horizon. The fragments range from 2 millimeters to 6 inches in size. The mollic epipedon is 10 to 18 inches thick.

The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It typically has distinct or prominent mottles in the lower part. It is loam, sandy loam, or fine sandy loam. Some pedons have a histic layer, which has hue of 7.5YR or 5YR. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 1 or 2. It commonly has distinct or prominent mottles throughout. It is fine sandy loam or sandy loam. The 2C horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 3 or 4.

Redeye Series

The Redeye series consists of deep, well drained soils on till plains and drumlins. These soils formed in sandy material 20 to 40 inches deep over dense, loamy glacial till. Permeability is rapid in the upper part of the profile and very slow in the underlying material. Slopes range from 2 to 12 percent.

Typical pedon of Redeye loamy sand, 2 to 6 percent slopes, 2,700 feet south and 400 feet east of the northwest corner of sec. 36, T. 132 N., R. 33 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; about 3 percent coarse fragments; medium acid; abrupt smooth boundary.

E—3 to 22 inches; brown (10YR 5/3) loamy sand, light gray (10YR 7/2) dry; weak fine subangular blocky structure; very friable; about 5 percent coarse fragments; medium acid; clear smooth boundary.

2Bt1—22 to 29 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; about 5 percent coarse fragments; many faint dark brown (10YR 3/3) clay films on faces of peds and lining tubular pores; medium acid; clear wavy boundary.

2Bt2—29 to 35 inches; yellowish brown (10YR 5/4) sandy loam; moderate medium subangular blocky structure; friable; about 5 percent coarse fragments; many distinct dark brown (7.5YR 3/2) clay films on faces of peds and lining tubular pores; neutral; clear wavy boundary.

2Cd1—35 to 41 inches; yellowish brown (10YR 5/4) dense till that crushes to sandy loam; moderate medium platy soil fragments; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

2Cd2—41 to 60 inches; yellowish brown (10YR 5/4) dense till that crushes to sandy loam; moderate thin platy soil fragments; friable; about 7 percent coarse fragments; fine irregularly shaped light gray (10YR 7/2) filaments of lime; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 35 to 54 inches. The sandy mantle ranges from 20 to 40 inches in thickness. It has coarse fragments in some pedons. The content of these fragments is 2 to 10 percent in the underlying glacial till. Most of the fragments are 2 millimeters to 3 inches in size.

The Ap or A horizon has value of 2 or 3 and chroma of 1 to 3. It is sand, fine sand, loamy sand, or loamy fine sand. The E horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is sand, fine sand, or loamy sand. The 2Bt horizon has value of 4 or 5 and chroma of 4 to 6. The 2Cd horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 4 or 5.

Rifle Series

The Rifle series consists of deep, very poorly drained, moderately permeable or moderately rapidly permeable soils in bogs and deep depressions on till plains, outwash plains, and moraines. These soils formed in herbaceous organic deposits more than 51 inches thick. Slopes are less than 1 percent.

Typical pedon of Rifle muck, 1,800 feet south and 300 feet east of the northwest corner of sec. 24, T. 132 N., R. 34 W.

Oa—0 to 9 inches; sapric material, black (10YR 2/1) and very dark brown (7.5YR 2/2) broken face and rubbed, dark brown (7.5YR 3/4) pressed; about 75 percent fiber unrubbed, 16 percent rubbed; weak medium and fine granular structure; very friable; medium acid; clear wavy boundary.

Oe1—9 to 36 inches; hemic material, dark brown (7.5YR 4/4) broken face and rubbed, dark brown (7.5YR 4/4) pressed; brown (7.5YR 5/4) fibers; about 90 percent fiber unrubbed, 25 percent rubbed; weak thin platy structure; friable; medium acid; clear wavy boundary.

Oe2—36 to 60 inches; hemic material, dark brown (7.5YR 4/4) and brown (7.5YR 5/4) broken face and pressed, dark brown (7.5YR 4/4) rubbed; about 90 percent fiber unrubbed, 30 percent rubbed; weak medium platy structure; friable; medium acid.

The organic material is more than 51 inches thick. It commonly is 6 to more than 10 feet thick. It is mainly herbaceous material, but in some pedons the content of woody fragments is as much as 15 percent.

The surface tier is fibric to sapric, depending on the stage of decomposition. The sapric material is more common in cultivated areas than in other areas. This tier has hue of 10YR to 5YR, value of 2 to 6, and chroma of 1 to 4. The subsurface and bottom tiers have hue of 10YR to 5YR and value and chroma of 2 to 4. They become darker when exposed to air. They are dominantly hemic material, but some pedons have layers of sapric or fibric material less than 10 inches thick.

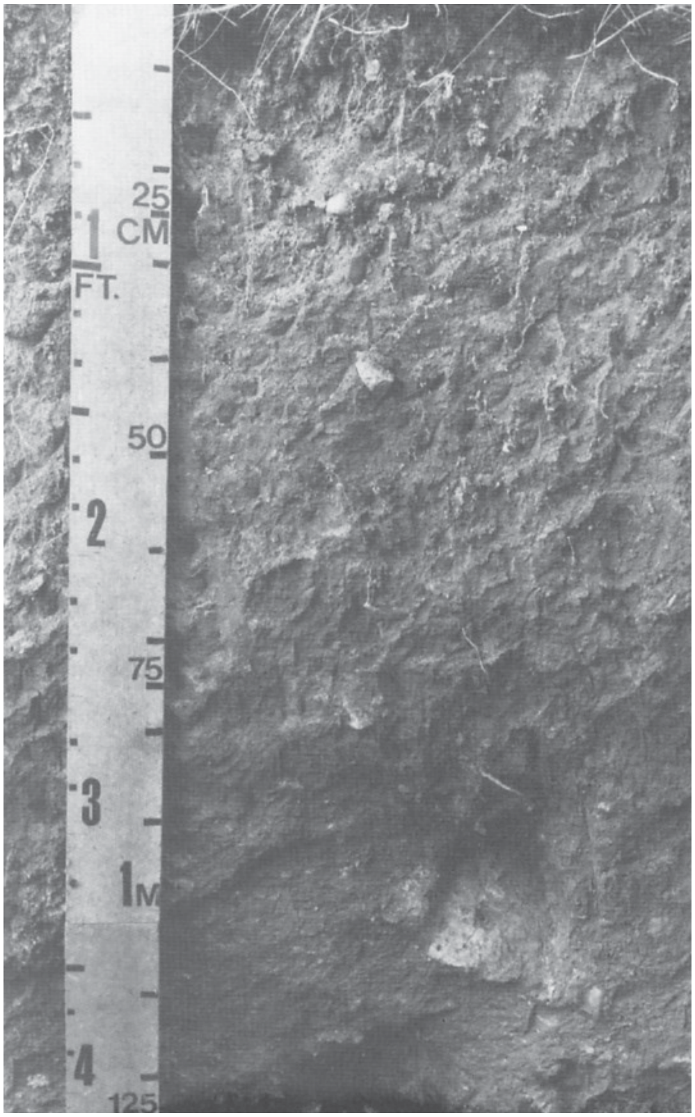

Figure 16.—Profile of Rockwood sandy loam, 2 to 6 percent slopes.

Rockwood Series

The Rockwood series consists of deep, well drained soils on drumlins (fig. 16). These soils formed in loamy glacial till. They are moderately permeable in the upper part and very slowly permeable in the underlying till. Slopes range from 2 to 25 percent.

Typical pedon of Rockwood sandy loam, 2 to 6 percent slopes, 50 feet south and 1,220 feet west of the northeast corner of sec. 18, T. 132 N., R. 34 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common fine roots; about 8 percent coarse fragments; strongly acid; abrupt smooth boundary.

E—8 to 16 inches; dark brown (10YR 4/3) sandy loam; weak medium platy structure; friable; common fine roots; about 9 percent coarse fragments; slightly acid; clear smooth boundary.

BE1—16 to 24 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; friable; few fine roots; many light brownish gray (10YR 6/2) sand grains on faces of peds; about 13 percent coarse fragments; slightly acid; clear wavy boundary.

BE2—24 to 37 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few fine roots; many light brownish gray (10YR 6/2) sand grains on faces of peds; about 10 percent coarse fragments; slightly acid; clear wavy boundary.

Bt—37 to 46 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate fine subangular blocky structure; firm; very few fine roots; common dark yellowish brown (10YR 3/4) clay films on faces of peds; about 10 percent coarse fragments; common very dark grayish brown (10YR 3/2) clay films in channels and pores; slightly acid; clear wavy boundary.

Cd—46 to 60 inches; yellowish brown (10YR 5/4) dense till that crushes to sandy loam; weak thin platy soil fragments; firm; about 10 percent coarse fragments; common very pale brown (10YR 7/3) concretions of carbonate; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 32 to 60 inches. The content of coarse fragments ranges from 5 to 15 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It typically is sandy loam, but fine sandy loam and loam are within the range. The E horizon has value of 4 to 6 and chroma of 2 to 4. It typically is sandy loam, but some pedons have subhorizons of loamy sand. Some pedons have an E/B or B/E horizon. The B horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 3 or 4. It typically is sandy loam, but some pedons have subhorizons of sandy clay loam. The Cd horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4.

Roliss Series

The Roliss series consists of deep, poorly drained soils on till plains. These soils formed in calcareous, loamy glacial till. Permeability is moderate or moderately slow. Slopes are 0 to 1 percent.

Typical pedon of Roliss loam, 2,400 feet west and 1,050 feet north of the southeast corner of sec. 30, T. 127 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium granular structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

A—9 to 16 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear wavy boundary.

Bg—16 to 24 inches; grayish brown (2.5Y 5/2) loam; few fine distinct brownish yellow (10YR 6/8) mottles; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Cg1—24 to 30 inches; grayish brown (2.5Y 5/2) loam; common fine faint light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

Cg2—30 to 44 inches; grayish brown (2.5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/4), yellowish brown (10YR 5/8), and light gray (2.5Y 7/2) mottles; weak thin platy structure; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline; abrupt wavy boundary.

Cg3—44 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium prominent yellowish brown (10YR 5/8), brownish yellow (10YR 6/8), and olive yellow (2.5Y 6/6) mottles; weak medium subangular blocky structure; friable; about 6 percent coarse fragments; violent effervescence; moderately alkaline.

The solum is 12 to 24 inches thick. It is dominantly loam or clay loam, but sandy clay loam is within the range. The mollic epipedon is 7 to 18 inches thick. The content of coarse fragments ranges from 2 to 20 percent throughout the profile. The fragments range from 2 millimeters to 3 inches in size.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 and chroma of 0. The B horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2. It commonly has mottles with higher chroma. The C horizon has hue of 2.5Y or 5Y and value of 4 to 6. It has chroma 1 or 2 in the upper part and chroma of 1 to 4 in the lower part. It has mottles with higher chroma in some pedons. It is loam or clay loam. The calcium carbonate equivalent generally is higher in the C horizon than in the solum.

Rondeau Series

The Rondeau series consists of deep, very poorly drained, slowly permeable or very slowly permeable soils in depressions on outwash plains and moraines. These soils formed in herbaceous organic material 16 to 50 inches deep over coprogenous earth. Slopes are less than 1 percent.

The Rondeau soils in Todd County are taxadjuncts to the series because they are underlain by coprogenous earth. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Rondeau muck, 1,600 feet east and 200 feet north of the southwest corner of sec. 1, T. 130 N., R. 32 W.

Oa1—0 to 9 inches; sapric material, black (10YR 2/1) broken face and rubbed, very dark brown (10YR 2/2) pressed; about 20 percent fiber unrubbed, less than 10 percent rubbed; weak fine granular structure; very friable; medium acid; clear wavy boundary.

Oa2—9 to 30 inches; sapric material, very dark brown (10YR 2/2) broken face and pressed, black (10YR 2/1) rubbed; about 50 percent fiber unrubbed, 10 percent rubbed; weak thin platy structure; friable; medium acid; abrupt wavy boundary.

Cg—30 to 60 inches; dark grayish brown (2.5Y 4/2) coprogenous earth; massive; very friable; strong effervescence; mildly alkaline.

The thickness of the sapric material ranges from 16 to 50 inches. The organic part of the control section has value of 2 or 3 and chroma of 1 or 2. The surface tier and the organic part of the lower tiers are typically sapric material, but some pedons have as much as 10 inches of hemic material. The content of fiber is typically less than 50 percent before rubbing and less than 10 percent after rubbing.

The Cg horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 to 4 and chroma of 0 to 2.

Some pedons have a thin layer of marl. This layer has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7, and chroma of 1 or 2. About 80 to 98 percent of the marl is mineral material, and more than 50 percent is calcium carbonate. Snail shells commonly make up as much as 50 percent of the volume.

Roscommon Series

The Roscommon series consists of poorly drained and very poorly drained, rapidly permeable soils on outwash plains. These soils formed in thick deposits of sandy material. Slopes range from 0 to 2 percent.

Typical pedon of Roscommon loamy sand, 1,600 feet north and 1,500 feet west of the southeast corner of sec. 24, T. 133 N., R. 33 W.

A—0 to 9 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; common fine faint strong brown (7.5YR 5/6) mottles; weak fine granular structure; very friable; neutral; clear smooth boundary.

Bg—9 to 20 inches; grayish brown (10YR 5/2) sand; common fine prominent yellowish brown (10YR 5/6) and common fine faint dark gray (10YR 4/1) mottles; single grained; loose; medium acid; clear wavy boundary.

BCg—20 to 36 inches; light brownish gray (10YR 6/2) sand; common medium prominent strong brown (7.5YR 4/6) mottles; single grained; loose; medium acid; clear wavy boundary.

C—36 to 60 inches; light olive brown (2.5Y 5/4) sand; common medium prominent strong brown (7.5YR 5/8) mottles; single grained; loose; medium acid.

The thickness of the solum ranges from 20 to 40 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2. It typically is loamy sand, but the range includes sand, mucky sand, and mucky loamy sand. The B horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It has few to many mottles. The control section and the C horizon are dominantly sand, but the range includes loamy sand. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It has few to many mottles.

Runeberg Series

The Runeberg series consists of deep, poorly drained and very poorly drained soils on drumlins and ground moraines. These soils formed in calcareous, loamy glacial till. Permeability is moderately slow or slow. Slopes range from 0 to 2 percent.

Typical pedon of Runeberg sandy loam, depressional, 2,650 feet north and 50 feet east of the southwest corner of sec. 32, T. 132 N., R. 34 W.

A—0 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; moderate fine and medium granular structure; friable; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

Bg1—10 to 18 inches; dark grayish brown (2.5Y 4/2) sandy loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

Bg2—18 to 26 inches; grayish brown (2.5Y 5/2) sandy loam; common fine faint light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; friable; about 9 percent coarse fragments; neutral; abrupt wavy boundary.

C—26 to 60 inches; grayish brown (2.5Y 5/2) sandy loam; common fine distinct light olive brown (2.5Y 5/6) mottles; medium platy soil fragments; friable; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates are 24 to 36 inches. The content of coarse fragments ranges from 3 to 15 percent throughout the profile. Most of the fragments range from 2 millimeters to 8 inches in size.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1 or 2. It is mottled in some pedons. It is typically sandy loam, but fine sandy loam and loam are within the range. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It has faint to prominent mottles. It is typically sandy loam, but loam is within the range. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 or 6, and chroma of 1 or 2. It has faint to prominent mottles.

Seelyeville Series

The Seelyeville series consists of deep, very poorly drained soils in postglacial basins. These soils formed in herbaceous material more than 51 inches thick. Permeability is moderately rapid to moderately slow. Slopes are less than 1 percent.

Typical pedon of Seelyeville muck, 1,220 feet west and 460 feet north of the southeast corner of sec. 36, T. 133 N., R. 33 W.

Oa1—0 to 10 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 75 percent fiber unrubbed, 10 percent rubbed; weak fine granular structure; very friable; slightly acid; clear wavy boundary.

Oa2—10 to 20 inches; sapric material, very dark gray (10YR 3/1) broken face and rubbed, very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) pressed; about 80 percent fiber unrubbed, 10 percent rubbed; weak very fine subangular blocky structure; very friable; medium acid; clear wavy boundary.

Oa3—20 to 60 inches; sapric material, very dark grayish brown (10YR 3/2) and dark yellowish brown (10YR 4/4) broken face, very dark gray (10YR 3/1) rubbed, dark brown (10YR 3/3) pressed; about 80 percent fiber unrubbed, 10 percent rubbed; weak medium subangular blocky structure; friable; strongly acid.

The organic material ranges from 51 to 100 inches in thickness. It is underlain by mineral or limnic material. It has no free carbonates. The surface tier is typically sapric material, but in some pedons it is partly or entirely hemic material. The subsurface and bottom tiers typically are sapric material, but some pedons have as much as 10 inches of hemic material. The sapric material has value of 2 or 3 and chroma of 1 or 2. The hemic material has hue of 10YR and value and chroma of 2 or 3.

Sioux Series

The Sioux series consists of deep, excessively drained soils on outwash plains and terraces. These soils formed in calcareous, sandy and gravelly material. Permeability is rapid or very rapid. Slopes range from 2 to 30 percent.

Typical pedon of Sioux loamy sand, 12 to 25 percent slopes, 1,300 feet south and 800 feet east of the northwest corner of sec. 25, T. 127 N., R. 35 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; about 10 percent coarse fragments; neutral; abrupt wavy boundary.

AC—8 to 13 inches; very dark grayish brown (10YR 3/2) gravelly loamy sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; about 20 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.

C—13 to 60 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) very gravelly coarse sand; single grained; loose; about 40 percent coarse fragments; few coatings of carbonate on the underside of pebbles; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 7 to 14 inches. The depth to free carbonates ranges from 0 to 8 inches. The 10- to 40-inch control section averages more than 35 percent coarse fragments.

The A horizon has value of 2 or 3. It is loam, gravelly loam, sandy loam, gravelly sandy loam, loamy sand, or gravelly loamy sand. The AC horizon has value of 3 or 4 and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is very gravelly sand, very gravelly loamy sand, or very gravelly coarse sand.

The Sioux soil in the map unit Dorset-Sioux sandy loams, 6 to 15 percent slopes, is a taxadjunct because it has fewer coarse fragments than is defined as the range for the series. The Sioux soils in the Hangaard-Sioux complex and in the Dorset-Sioux complex, 15 to 30 percent slopes, also are taxadjuncts because they have fewer coarse fragments and do not have a mollic epipedon. These differences, however, do not significantly affect the use and management of the soils.

Staples Series

The Staples series consists of deep, poorly drained soils in shallow depressions. These soils formed in sandy outwash or eolian material 20 to 40 inches deep over loamy glacial till. Permeability is rapid in the upper part of the profile and very slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Staples loamy sand, 100 feet west and 1,500 feet north of the southeast corner of sec. 25, T. 133 N., R. 33 W.

Ap—0 to 6 inches; black (10YR 2/1) loamy sand, dark grayish brown (10YR 4/2) dry; few fine distinct light brownish gray (10YR 6/2) mottles; weak medium granular structure; very friable; medium acid; abrupt wavy boundary.

Eg1—6 to 12 inches; dark grayish brown (10YR 4/2) loamy sand, gray (10YR 6/1) dry; few fine faint brownish yellow (10YR 6/8) mottles; weak medium subangular blocky structure; very friable; medium acid; clear wavy boundary.

Eg2—12 to 21 inches; grayish brown (10YR 5/2) sand; common medium distinct dark yellowish brown (10YR 4/6) and gray (10YR 6/1) mottles; single grained; loose; medium acid; clear wavy boundary.

Eg3—21 to 25 inches; grayish brown (10YR 5/2) sand; many coarse prominent dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/8) mottles; single grained; loose; medium acid; clear wavy boundary.

2Btg—25 to 44 inches; grayish brown (2.5Y 5/2) sandy loam; many coarse prominent strong brown (7.5YR 5/8) mottles; moderate medium subangular blocky structure; friable; about 9 percent coarse fragments; common distinct grayish brown (10YR 5/2) clay films lining pores; slightly acid; clear wavy boundary.

2Cd—44 to 60 inches; olive gray (5Y 5/2) dense till that crushes to sandy loam; many medium distinct strong brown (7.5YR 5/6) mottles; weak thin platy structure; friable; about 5 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 36 to 60 inches. The depth to the loamy 2B horizon ranges from 20 to 40 inches. The depth to free carbonates ranges from 42 to more than 72 inches. The sandy sediments generally have no coarse fragments. In some pedons, however, the content of these fragments is as much as 10 percent in a stone line at the base of these sediments. Most of the fragments range from 2 millimeters to 3 inches in size.

The A and E horizons are dominantly loamy sand or sand, but the range includes fine sand and loamy fine sand. The A horizon has value of 2 to 4 and chroma of 1 or 2. The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It commonly is mottled. The 2Btg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It typically has distinct or prominent mottles. It is sandy loam or sandy clay loam. The 2Cd horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 or 6, and chroma of 1 to 3.

Sverdrup Series

The Sverdrup series consists of deep, well drained, moderately rapidly permeable soils on outwash plains and moraines. These soils formed in calcareous, moderately coarse textured glacial outwash of mixed mineralogy. They are underlain by calcareous sand. Slopes range from 0 to 6 percent.

Typical pedon of Sverdrup sandy loam, 2 to 6 percent slopes, 175 feet north and 2,375 feet east of the southwest corner of sec. 25, T. 127 N., R. 35 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; about 1 percent coarse fragments; very friable; slightly acid; abrupt smooth boundary.

A—8 to 14 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine and medium subangular blocky structure; about 1 percent coarse fragments; friable; slightly acid; gradual wavy boundary.

Bw—14 to 22 inches; dark brown (10YR 4/3) sandy loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; about 1 percent coarse fragments; slightly acid; gradual wavy boundary.

BC—22 to 28 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

C—28 to 60 inches; brown (10YR 5/3) and pale brown (10YR 6/3) sand; single grained; loose; about 1 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 16 to 30 inches. The depth to free carbonates ranges from 15 to 40 inches. The mollic epipedon is 10 to 16 inches thick. The depth to loamy sand or coarser textured material is 14 to 24 inches. In some pedons the content of coarse fragments is as much as 10 percent throughout the profile. Most of the fragments range from 2 millimeters to 1 inch in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It typically is sandy loam, but fine sandy loam and loam are within the range. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is sandy loam, fine sandy loam, or loam in the upper part and loamy sand or sand in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It typically is sand, but some pedons have strata of fine sand.

Tacoosh Series

The Tacoosh series consists of deep, very poorly drained soils in depressions. These soils formed in herbaceous material 16 to 50 inches deep over loamy glacial sediments. Permeability is moderately rapid in the organic material and moderate in the underlying material. Slopes are less than 1 percent.

Typical pedon of Tacoosh mucky peat, 980 feet north and 200 feet west of the southeast corner of sec. 34, T. 133 N., R. 34 W.

Oe1—0 to 9 inches; hemic material, black (10YR 2/1) broken face, dark brown (7.5YR 3/2) rubbed and pressed; about 80 percent fiber unrubbed, 20 percent rubbed; weak medium subangular blocky structure; very friable; medium acid; clear wavy boundary.

Oe2—9 to 26 inches; hemic material, dark brown (7.5YR 4/4) broken face and rubbed, strong brown (7.5YR 5/6) pressed; about 80 percent fiber unrubbed, 30 percent rubbed; weak medium subangular blocky structure; friable; medium acid; clear wavy boundary.

Oe3—26 to 30 inches; sapric material, black (N 2/0) broken face and rubbed, dark brown (10YR 3/3) pressed; about 50 percent fiber unrubbed, 20 percent rubbed; weak medium platy structure; friable; medium acid; abrupt wavy boundary.

C—30 to 60 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) sandy loam; massive; friable; neutral.

The thickness of the hemic material ranges from 16 to 50 inches. The organic material is mainly of herbaceous origin, but in some pedons the content of woody fragments is as much as 20 percent.

Some pedons have a mat of living sphagnum moss as much as 6 inches thick. The organic part of the control section has hue of 10YR, 7.5YR, or 5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 4. The surface tier is hemic or sapric material. The subsurface tier is hemic material that has less than 5 inches of sapric or fibric material.

The C horizon has hue of 2.5Y to 5YR, value of 4 to 6, and chroma of 1 or 2. It is sandy loam, loam, silt loam, or clay loam.

Ves Series

The Ves series consists of deep, well drained, moderately permeable soils on ground moraines and till plains. These soils formed in calcareous, loamy glacial till. Slopes range from 2 to 12 percent.

The Ves soils in Todd County formed under a colder climate than is typical for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Ves loam, 2 to 6 percent slopes, 2,250 feet north and 1,650 feet east of the southwest corner of sec. 27, T. 127 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; about 7 percent coarse fragments; neutral; clear smooth boundary.

A—9 to 14 inches; about 70 percent very dark brown (10YR 2/2) loam mixed with about 30 percent black (10YR 2/1) loam, dark grayish brown (10YR 4/2) and dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

Bw—14 to 26 inches; dark yellowish brown (10YR 4/4) loam; moderate fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; neutral; abrupt wavy boundary.

Bk—26 to 35 inches; olive brown (2.5Y 4/4) loam; weak fine subangular blocky structure; friable; about 8 percent coarse fragments; many fine irregularly shaped light gray (2.5YR 7/2 and 7/1) masses and seams of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C—35 to 60 inches; olive brown (2.5Y 4/4) loam; moderate medium subangular blocky structure; friable; about 5 percent coarse fragments; common fine irregularly shaped light gray (2.5Y 7/2) masses of lime in seams; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 45 inches. The mollic epipedon is 10 to 16 inches thick. The content of coarse fragments is 3 to 8 percent throughout the profile. Most of the fragments are 2 to 5 millimeters in size. The soils are loam or clay loam throughout.

The A horizon has value 2 or 3 and chroma of 1 or 2. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 3 or 4. In most pedons the lower part of this horizon qualifies as a calcic horizon. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4.

Waukon Series

The Waukon series consists of deep, well drained, moderately permeable soils on moraines. These soils formed in loamy glacial till. Slopes range from 2 to 25 percent.

Typical pedon of Waukon loam, 2 to 6 percent slopes, 2,050 feet west and 600 feet south of the northeast corner of sec. 1, T. 127 N., R. 35 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; about 4 percent coarse fragments; slightly acid; abrupt smooth boundary.

E—7 to 10 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak thin platy structure; very friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

Bt1—10 to 16 inches; dark brown (10YR 4/3) loam; moderate medium and fine subangular blocky structure; friable; about 4 percent coarse fragments; few faint very dark grayish brown (10YR 3/2) clay films on faces of peds and lining tubular pores; slightly acid; clear wavy boundary.

Bt2—16 to 25 inches; dark brown (10YR 4/3) loam; moderate medium subangular blocky structure; firm; about 5 percent coarse fragments; many distinct dark brown (10YR 3/3) clay films on faces of peds and very dark grayish brown (10YR 3/2) clay films lining tubular pores; slightly acid; clear wavy boundary.

Bt3—25 to 31 inches; dark yellowish brown (10YR 4/4) loam; weak fine and medium subangular blocky structure; friable; about 6 percent coarse fragments; common distinct dark brown (10YR 3/3) clay films on faces of peds and very dark grayish brown (10YR 3/2) clay films lining a few pores; neutral; abrupt wavy boundary.

C—31 to 60 inches; light olive brown (2.5Y 5/4) loam; weak thin platy structure; friable; fine irregularly shaped light gray (10YR 7/2) accumulations of lime in seams; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 40 inches. The content of coarse fragments is 2 to 8 percent throughout the profile. These fragments range from 2 millimeters to 3 inches in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The E horizon has value of 3 or 4 and chroma of 1 or 2. It is dominantly loam, but the range includes fine sandy loam and clay loam. The B and C horizons are clay loam or loam. The B horizon has value of 4 or 5 and chroma of 3 or 4. The C horizon has hue of 2.5Y or 10YR, value of 5 or 6, and chroma of 3 or 4.

Wykeham Series

The Wykeham series consists of deep, moderately well drained, moderately slowly permeable soils on ground and end moraines. These soils formed in calcareous, loamy glacial till. Slopes range from 1 to 3 percent.

Typical pedon of Wykeham fine sandy loam, 1,140 feet north and 27 feet east of the center of sec. 20, T. 131 N., R. 35 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; many fine roots; about 3 percent coarse fragments; strongly acid; abrupt smooth boundary.

E—7 to 11 inches; grayish brown (10YR 5/2) gravelly sandy loam, light brownish gray (10YR 6/2) dry; moderate thin platy structure; friable; common fine roots; about 28 percent coarse fragments; strongly acid; clear wavy boundary.

BE—11 to 19 inches; dark yellowish brown (10YR 4/4) fine sandy loam; moderate fine subangular blocky structure; friable; common fine roots; many pale brown (10YR 6/3) sand grains on faces of peds; about 5 percent coarse fragments; strongly acid; clear wavy boundary.

Bt1—19 to 24 inches; dark yellowish brown (10YR 4/4) sandy clay loam; common fine distinct dark grayish brown (10YR 4/2) mottles; moderate fine subangular blocky structure; friable; few fine roots; about 4 percent coarse fragments; many distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; clear wavy boundary.

Bt2—24 to 28 inches; yellowish brown (10YR 5/6) sandy clay loam; common fine distinct grayish brown (10YR 5/2) mottles; weak coarse prismatic structure; friable; few fine roots; about 3 percent coarse fragments; many prominent very dark grayish brown (10YR 3/2) clay films on faces of peds; neutral; clear wavy boundary.

BC—28 to 38 inches; yellowish brown (10YR 5/6) fine sandy loam; common fine distinct dark grayish brown (10YR 4/2) mottles; weak thin platy structure; friable; very few fine roots; about 5 percent coarse fragments; common light gray (10YR 7/2) filaments of calcium carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

C1—38 to 52 inches; yellowish brown (10YR 5/6) fine sandy loam; common fine distinct dark grayish brown (10YR 4/2) mottles; weak medium platy soil fragments; friable; about 5 percent coarse fragments; common light gray (10YR 7/2) filaments of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—52 to 60 inches; yellowish brown (10YR 5/6) fine sandy loam; moderate medium platy soil fragments; friable; about 13 percent coarse fragments; common light gray (10YR 7/2) filaments of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 50 inches. The content of coarse fragments ranges from 2 to 30 percent throughout the profile. Most of the fragments range from 2 millimeters to 3 inches in size.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly fine sandy loam, but sandy loam is within the range. The E horizon has value of 4 or 5 and chroma of 2 or 3. It typically is gravelly sandy loam, but sandy loam is within the range. This horizon interfingers into the B horizon in most pedons. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 8. It is sandy clay loam or sandy loam. It has few to many, faint or distinct clay films. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 6. It is sandy loam or fine sandy loam.

Zimmerman Series

The Zimmerman series consists of deep, excessively drained, rapidly permeable soils in plane or convex areas on outwash plains. These soils formed in sandy glacial sediments. Slopes range from 1 to 15 percent.

Typical pedon of Zimmerman loamy fine sand, 1 to 6 percent slopes, 1,450 feet south and 300 feet east of the northwest corner of sec. 21, T. 131 N., R. 32 W.

A—0 to 4 inches; black (10YR 2/1) loamy fine sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; strongly acid; clear wavy boundary.

E—4 to 18 inches; brown (10YR 5/3) fine sand; single grained; loose; strongly acid; abrupt wavy boundary.

E&Bt—18 to 48 inches; yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) fine sand (E); single grained; loose; common, discontinuous, dark brown (7.5YR 4/4) bands of loamy fine sand (Bt) 0.5 inch to 1.5 inches thick; weak fine subangular blocky structure; friable; medium acid; abrupt wavy boundary.

C—48 to 60 inches; brown (7.5YR 5/4) and strong brown (7.5YR 5/6) fine sand; single grained; loose; slightly acid.

The thickness of the solum ranges from 40 to 80 inches. The depth to lamellae ranges from 30 to 60 inches.

The A horizon has chroma of 1 or 2. It is loamy fine sand or fine sand. The E horizon has value of 4 to 7 and chroma of 2 to 4. It is dominantly fine sand, but in some pedons the upper part is loamy fine sand. Some pedons have a separate B horizon, which has hue of 10YR, value of 4 to 6, and chroma of 3 to 5. The Bt part of the E&Bt horizon occurs as discontinuous or continuous lamellae. It has hue of 5YR to 10YR, value of 3 to 5, and chroma of 2 to 6. It is dominantly loamy fine sand or fine sand, but the range includes very fine sand, loamy very fine sand, and fine sandy loam. The C horizon has hue of 7.5YR to 2.5Y, value of 5 to 7, and chroma of 2 to 6. It is sand or fine sand.

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Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material accumulated and has existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land, and the resulting drainage conditions; and the length of time that the forces of soil formation have acted on the soil material. These factors are interdependent. Few generalizations can be made regarding the effects of any one factor unless the effects of the others are considered.

Human activities have influenced the formation of soils by disturbing the natural balance of certain factors or altering related conditions. Removal of the natural vegetation and tillage have accelerated erosion. Some human activities have changed the drainage condition or relief. Additions of fertilizer, use of organic residue, and a cropping system that does not replace plant nutrients have modified the natural differences among the soils.

Parent Material

Todd County is in a formerly glaciated region characterized by drumlins, till plains, moraines, lakes, and outwash plains. The parent material of the soils is dominantly glacial till or outwash.

Most of the county is covered by glacial till which generally is 200 to 400 feet thick. Wisconsin-age glaciers covered the survey area at various times. The most recent glaciation ended 10,000 to 20,000 years ago.

Des Moines till is at the surface in the southwest corner of the county. It is light olive brown or olive brown, mottled loam or clay loam. Wadena Lobe till is in the northern and central parts of the county, on the Osakis till plain. It is dark yellowish brown or yellowish brown sandy loam. Till deposited by the Rainy and Superior Lobes is neutral or acid, dark brown and strong brown sandy loam. It is along the eastern edge of the county. The terminus of the Rainy Lobe is the St. Croix moraine complex.

Glacial outwash is material deposited by streams of meltwater that flowed out of the retreating glaciers. In most areas the soils are nearly level to undulating. In some areas in the northeastern part of the county, however, they are rolling to steep. Most of the outwash is stratified and well sorted, but it is poorly sorted in many areas where it is near glacial till. It is sand and gravel or well sorted sand.

Because the kinds of material in the glacial outwash vary greatly, many different kinds of soil formed in this parent material. The texture ranges from loamy sand to clay loam in the upper part of the profile. Generally, sand and gravel are within 4 feet of the surface, but depth to the sand and gravel varies. Large stones are mixed with the outwash in places. Arvilla, Dorset, Sioux, and Sverdrup are some of the major soils that formed in glacial outwash.

Soils that formed in organic material are in many sloughs and potholes and along some stream channels throughout the county. The water table is high in these wet areas. The environment in and adjacent to these areas has encouraged the growth of many plants, such as cattails, sedges, reeds, grasses, and shrubs. After these plants die, their remains are covered by the water in which the plants grew. Because the water shuts out air, the decomposition rate is reduced. Thus, the organic material accumulates more rapidly than it decomposes. Peats and mucks formed in plant remains in various stages of decomposition. Bowstring, Cathro, and Rifle are some of the major soils that formed in organic material.

Alluvium was deposited along the streams in the county. In most places it is dark and calcareous. Aquents are the principal soils that formed in the alluvium in the county. Colluvium has accumulated in drainageways, on alluvial fans, and near the base of the steeper slopes. This material is similar to alluvium, but it is not calcareous. Bluffton soils formed in colluvium.

Climate

Rainfall and temperature directly affect the weathering of parent material. Water from rainfall and melting snow dissolves minerals, supports biological activity, and transports mineral and organic residue through the profile. Temperature influences the kinds of organisms that grow on the soil and their rate of growth. Alternate periods of freezing and thawing hasten the mechanical disintegration of the parent material. Summer heat and humidity speed chemical weathering.

Climate affects the soil indirectly through its influence on the kinds of plants and animals on and in the soil. The primary source of the organic matter in a soil is vegetation. Animals that live in the soil help to convert dead leaves, stems, roots, and other plant remains to plant nutrients.

Todd County has a cool, subhumid, continental climate marked by wide variations in temperature from summer to winter. In winter the soil-forming processes are largely dormant. Generally, the soils are frozen to a depth of 3 to 5 feet for 4 to 5 months of the year. The depth to which frost penetrates depends on the amount of snow that accumulates on the surface late in fall or early in winter.

The climate is essentially uniform throughout the county, but differences in vegetation, soil material, and relief can cause variations in the microclimate. Soils on the prairie are exposed to greater variations in temperature than those in the forest. Ves and other fine textured soils warm up more slowly in spring than Arvilla, Dorset, and other coarse textured soils because they contain more moisture. Soils on south- and west-facing slopes receive more sunlight and generally are drier and warmer than soils on north- and east-facing slopes.

Plant and Animal Life

Plants and animals help to decompose plant residue. They also affect the chemistry of the soil and increase the rate of soil formation. Micro-organisms help to transform undecomposed organic matter into humus. The action of bacteria and various kinds of fungi causes the decay of dead leaves and other organic matter. Earthworms and small burrowing animals help to mix humus with the soil material. Decayed organic matter gradually changes the physical and chemical composition of the surface soil.

In Todd County trees and prairie grasses have strongly influenced soil formation. The county is on the southern edge of an area of hardwood forest. At the time when the county was settled, about three-fourths of the acreage was forested and one-fourth was covered partly by prairie grasses and partly by trees. The prairie vegetation encroached on the forest or the forest vegetation on the prairie either because of climatic changes or because of fire.

In soils that formed under similar conditions of relief, drainage, parent material, and time, the surface layer is thicker and darker in the areas of prairie than in the areas of forest. Tall prairie grasses have affected the formation of Normania, Ves, Arvilla, and Flom soils.

The surface layer of Waukon, Gonvick, Dorset, and other soils that formed under both prairie grasses and trees is intermediate in thickness between that of the soils that formed under prairie grasses and that of the soils that formed under trees. The subsurface layer, if it occurs, generally resembles the gray, leached horizon typical of forest soils. This horizon varies in distinctness. The subsoil has an increased content of clay particles and a large accumulation of organic matter.

The surface layer of Cushing, Rockwood, and other soils that formed under trees is thin. The subsurface layer is thick, leached, and gray. It has a marked increase in content of clay particles and a large accumulation of organic matter.

Relief

Relief is an important factor in the formation of soils because of its effect on drainage, aeration, and erosion. Differences in relief can account for differences among soils that formed in the same kind of parent material. Three major kinds of relief are evident in Todd County. These are in the irregular morainic areas, mainly in the eastern half of the county; the smooth glacial outwash areas in the central and northeastern parts of the county; and the gently sloping till plains in the eastern and southeastern parts.

In the soils on knolls and in the steeper soils, such as Langhei, less water percolates through the profile because more water runs off the surface. In gently sloping soils, more water percolates through the profile. In many places these soils are deeper than the more sloping soils because less water runs off the surface. Runeberg, Prebish, and other soils in low areas receive much more water than can percolate through the profile. As a result, these soils are wet during a large part of the growing season. They have a thick surface layer. Soils in swales commonly are leached of salts to a depth of 3 to more than 6 feet.

Time

After the last glacier receded, about 10,000 to 12,000 years ago, the glacial drift had a calcareous surface but no soil profile. It probably could not support the vegetation or crops that are now grown or that were growing before the county was settled. The plants that were able to grow in the cold climate on the fresh parent material contributed to the formation of the soils. In time, the resulting changes in the soils permitted other kinds of plants to grow. The succession of plants and of soils, with time, was ultimately controlled by the climate. The balance among the soil, climate, and vegetation was changed when the land in the county was cleared and plowed about 120 years ago.

Although the parent material has been in place for many hundreds of years, many of the soils are not more than a few hundred or a few thousand years old. Because of the intensity of the soil-forming processes, Kandota, Waukon, and similar soils have moderately distinct layers. Langhei soils, which have gentle to steep slopes, are continuously subject to erosion and show little evidence of horizon development. Soils formed in the alluvium adjacent to the major drainageways show little or no evidence of profile development. Flom soils are in areas where a fluctuating water table modifies the normal effects of time.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Congeliturbate. Soil material disturbed by frost action.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Selected methods of irrigation are—

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Sloughed till. Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

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Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-80 at Long Prairie, Minnesota)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	16.9	-4.3	6.3	42	-35	0	0.92	0.19	1.47	3	10.5
February----	24.7	1.6	13.2	46	-31	0	.79	.24	1.24	3	8.1
March-------	35.6	14.4	25.0	61	-24	10	1.53	.48	2.38	4	10.2
April-------	54.0	31.4	42.7	83	9	40	2.18	1.01	3.17	6	2.6
May---------	68.1	43.1	55.6	89	23	217	3.05	1.40	4.45	7	.1
June--------	77.1	53.1	65.1	94	35	453	4.00	2.18	5.59	8	.0
July--------	82.5	57.7	70.1	96	41	623	3.87	1.66	5.75	7	.0
August------	80.0	55.4	67.7	95	37	549	3.89	1.69	5.75	6	.0
September---	69.9	45.7	57.8	91	25	242	2.47	1.03	3.68	5	.0
October-----	58.9	35.6	47.3	83	14	90	1.87	.53	2.93	4	.8
November----	38.8	21.0	29.9	64	-11	0	1.24	.38	1.94	3	4.7
December----	24.0	5.7	14.9	47	-28	0	.92	.32	1.40	3	8.7
Yearly:											
Average---	52.5	30.4	41.3	---	---	---	---	---	---	---	---
Extreme---	---	---	---	97	-36	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,224	26.73	20.74	32.33	59	45.7

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-80 at Long Prairie, Minnesota)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 8	May 14	May 29
2 years in 10 later than--	May 3	May 10	May 24
5 years in 10 later than--	Apr. 23	May 3	May 16
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 26	Sept. 16	Sept. 10
2 years in 10 earlier than--	Oct. 2	Sept. 20	Sept. 13
5 years in 10 earlier than--	Oct. 12	Sept. 29	Sept. 20

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-80 at Long Prairie, Minnesota)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	148	129	109
8 years in 10	156	136	115
5 years in 10	172	149	126
2 years in 10	187	162	137
1 year in 10	195	169	143

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
7A	Hubbard loamy sand, 0 to 2 percent slopes	3,700	0.6
7B	Hubbard loamy sand, 2 to 6 percent slopes	10,825	1.7
36	Flom loam	6,850	1.1
38B	Waukon loam, 2 to 6 percent slopes	3,775	0.6
38C	Waukon loam, 6 to 12 percent slopes	1,025	0.2
53B	Kandota sandy loam, 2 to 6 percent slopes	27,750	4.3
53C	Kandota sandy loam, 6 to 12 percent slopes	10,100	1.6
53D	Kandota sandy loam, 12 to 25 percent slopes	1,850	0.3
75	Bluffton loam	840	0.1
82B	Redeye loamy sand, 2 to 6 percent slopes	2,825	0.5
82C	Redeye loamy sand, 6 to 12 percent slopes	1,780	0.3
111	Hangaard sandy loam	2,325	0.4
121	Wykeham fine sandy loam	8,625	1.4
127A	Sverdrup sandy loam, 0 to 2 percent slopes	2,850	0.5
127B	Sverdrup sandy loam, 2 to 6 percent slopes	2,800	0.4
139B	Huntersville loamy sand, 1 to 4 percent slopes	2,250	0.4
142	Nokay sandy loam	3,250	0.5
144B	Flak sandy loam, 2 to 6 percent slopes	2,900	0.5
144C	Flak sandy loam, 6 to 12 percent slopes	1,700	0.3
158B	Zimmerman loamy fine sand, 1 to 6 percent slopes	950	0.2
158C	Zimmerman loamy fine sand, 6 to 15 percent slopes	200	*
163B	Brainerd sandy loam, 1 to 4 percent slopes	1,675	0.3
169B	Braham loamy sand, 1 to 6 percent slopes	475	0.1
170	Blomford loamy sand	475	0.1
180	Gonvick loam	7,300	1.2
183	Dassel mucky sandy loam	420	0.1
200B	Holdingford sandy loam, 2 to 6 percent slopes	1,425	0.2
200C	Holdingford sandy loam, 6 to 12 percent slopes	670	0.1
202	Meehan loamy sand	8,050	1.3
204B	Cushing sandy loam, 2 to 8 percent slopes	7,975	1.3
204C	Cushing sandy loam, 8 to 15 percent slopes	3,600	0.6
204E	Cushing sandy loam, 15 to 45 percent slopes	1,120	0.2
207B	Nymore loamy sand, 1 to 6 percent slopes	5,425	0.9
207C	Nymore loamy sand, 6 to 12 percent slopes	485	0.1
260	Duelm loamy sand	8,275	1.3
261	Isan loamy sand	6,075	1.0
292	Alstad sandy loam	4,250	0.7
325	Prebish fine sandy loam	575	0.1
341A	Arvilla sandy loam, 0 to 2 percent slopes	3,100	0.5
341B	Arvilla sandy loam, 2 to 6 percent slopes	3,900	0.6
341C	Arvilla sandy loam, 6 to 12 percent slopes	1,080	0.2
374B	Rockwood sandy loam, 2 to 6 percent slopes	55,575	8.7
374C	Rockwood sandy loam, 6 to 12 percent slopes	10,430	1.7
374D	Rockwood sandy loam, 12 to 25 percent slopes	2,825	0.5
375	Forada sandy loam	9,300	1.5
402C	Sioux loamy sand, 2 to 12 percent slopes	830	0.1
402E	Sioux loamy sand, 12 to 25 percent slopes	810	0.1
406B	Dorset sandy loam, 2 to 6 percent slopes	9,215	1.4
406C	Dorset sandy loam, 6 to 12 percent slopes	640	0.1
413	Osakis sandy loam	4,550	0.7
421B	Ves loam, 2 to 6 percent slopes	5,125	0.8
421C	Ves loam, 6 to 12 percent slopes	300	*
446	Normania loam	2,975	0.5
453B	DeMontreville loamy sand, 2 to 8 percent slopes	5,200	0.8
453C	DeMontreville loamy sand, 8 to 15 percent slopes	1,450	0.2
454B	Mahtomedi loamy sand, 1 to 8 percent slopes	1,120	0.2
454C	Mahtomedi loamy coarse sand, 8 to 15 percent slopes	980	0.2
454E	Mahtomedi loamy coarse sand, 15 to 45 percent slopes	1,125	0.2
458B	Menahga loamy sand, 2 to 6 percent slopes	11,800	1.9
458C	Menahga loamy sand, 6 to 12 percent slopes	2,675	0.4
458E	Menahga loamy sand, 12 to 25 percent slopes	1,810	0.3

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
514	Tacoosh mucky peat	8,925	1.4
540	Seelyeville muck	5,175	0.8
541	Rifle muck	40,350	6.3
543	Markey muck	9,575	1.5
544	Cathro muck	9,500	1.5
545	Rondeau muck	870	0.1
565	Eckvoll loamy sand	700	0.1
571	Coriff sandy loam	1,125	0.2
572	Lowlein sandy loam	780	0.1
582	Roliss loam	8,650	1.4
701	Runeberg sandy loam, depressional	25,100	4.0
703	Paddock sandy loam	39,400	6.3
720B	Blowers sandy loam, 1 to 5 percent slopes	59,880	9.5
800B	Kandota-Dorset sandy loams, 2 to 6 percent slopes	1,925	0.3
800C	Kandota-Dorset sandy loams, 6 to 15 percent slopes	3,825	0.6
800E	Kandota-Dorset sandy loams, 15 to 40 percent slopes	4,125	0.7
808	Wykeham-Runeberg sandy loams	2,350	0.4
823	Hangaard-Sioux complex	470	0.1
824C	Dorset-Sioux sandy loams, 6 to 15 percent slopes	1,475	0.2
824E	Dorset-Sioux complex, 15 to 30 percent slopes	1,775	0.3
825	Gonvick-Flom loams	2,450	0.4
873	Prebish-Nokay sandy loams	3,850	0.6
928B	Cushing-DeMontreville-Mahtomedi complex, 2 to 8 percent slopes	6,180	1.0
928C	Cushing-DeMontreville-Mahtomedi complex, 8 to 15 percent slopes	9,450	1.5
928E	Cushing-DeMontreville-Mahtomedi complex, 15 to 45 percent slopes	16,200	2.6
967C	Waukon-Langhei loams, 4 to 12 percent slopes	2,125	0.3
967D	Waukon-Langhei loams, 12 to 25 percent slopes	975	0.2
1015	Psamments, nearly level to sloping	300	*
1029	Pits, gravel	555	0.1
1054	Prebish and Histosols, ponded	960	0.2
1055	Aquolls and Histosols, ponded	8,050	1.3
1926	Bowstring-Aquents complex	16,250	2.6
1927	Clotho sandy loam	3,425	0.5
1932	Runeberg sandy loam	4,400	0.7
1943	Roscommon loamy sand	6,100	1.0
1956	Staples loamy sand	1,380	0.2
	Water	24,320	3.9
	Total	627,200	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
36	Flom loam (where drained)
38B	Waukon loam, 2 to 6 percent slopes
53B	Kandota sandy loam, 2 to 6 percent slopes
121	Wykeham fine sandy loam
142	Nokay sandy loam (where drained)
144B	Flak sandy loam, 2 to 6 percent slopes
163B	Brainerd sandy loam, 1 to 4 percent slopes
180	Gonvick loam
200B	Holdingford sandy loam, 2 to 6 percent slopes
204B	Cushing sandy loam, 2 to 8 percent slopes
292	Alstad sandy loam
374B	Rockwood sandy loam, 2 to 6 percent slopes
421B	Ves loam, 2 to 6 percent slopes
446	Normania loam
571	Coriff sandy loam (where drained)
572	Lowlein sandy loam
582	Roliss loam (where drained)
703	Paddock sandy loam (where drained)
720B	Blowers sandy loam, 1 to 5 percent slopes
808	Wykeham-Runeberg sandy loams (where drained)
825	Gonvick-Flom loams (where drained)
873	Prebish-Nokay sandy loams (where drained)
1927	Clotho sandy loam (where drained)
1932	Runeberg sandy loam (where drained)

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Kentucky bluegrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
7A-------------- Hubbard	IVs	55	8	10	45	2.2	3.3	2.0
7B-------------- Hubbard	IVs	55	7	10	45	2.2	3.3	2.0
36-------------- Flom	IIw	95	16	30	80	4.0	6.0	3.0
38B------------- Waukon	IIe	115	17	30	75	5.5	8.3	3.0
38C------------- Waukon	IIIe	110	16	28	65	4.5	6.7	2.5
53B------------- Kandota	IIe	105	15	---	75	5.0	7.5	3.0
53C------------- Kandota	IIIe	100	14	---	70	4.5	6.7	3.0
53D------------- Kandota	IVe	80	12	---	60	3.5	5.3	2.4
75-------------- Bluffton	IIIw	75	10	---	60	---	---	3.5
82B------------- Redeye	IIIs	75	12	---	60	3.0	4.5	2.5
82C------------- Redeye	IIIe	65	10	---	50	3.0	4.5	2.0
111------------- Hangaard	IVw	60	8	---	55	2.5	3.7	---
121------------- Wykeham	I	115	15	---	85	5.0	7.5	3.5
127A------------ Sverdrup	IIIs	60	12	18	50	2.8	4.2	3.0
127B------------ Sverdrup	IIIe	55	11	15	45	2.5	3.7	2.5
139B------------ Huntersville	IIIs	85	11	---	60	4.0	6.0	2.5
142------------- Nokay	IIw	80	15	---	70	4.0	6.0	3.0
144B------------ Flak	IIe	80	13	---	75	4.5	6.7	3.0
144C------------ Flak	IIIe	70	12	---	65	4.0	4.0	3.0

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Kentucky bluegrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
158B------------ Zimmerman	IVs	65	10	---	50	2.5	3.7	2.2
158C------------ Zimmerman	VIs	---	---	---	---	2.5	3.7	2.5
163B------------ Brainerd	IIe	100	15	25	70	4.5	6.7	3.0
169B------------ Braham	IIIs	75	11	20	55	3.0	4.5	2.5
170------------- Blomford	IIIw	60	10	24	60	3.0	4.5	2.5
180------------- Gonvick	I	120	17	33	80	5.5	8.3	3.0
183------------- Dassel	IIIw	70	10	23	60	2.4	3.5	2.5
200B------------ Holdingford	IIe	90	16	25	70	4.5	6.7	3.2
200C------------ Holdingford	IIIe	75	14	22	65	4.2	6.3	3.0
202------------- Meehan	IVw	50	8	23	50	2.0	---	1.3
204B------------ Cushing	IIe	100	17	36	80	4.5	6.7	3.5
204C------------ Cushing	IIIe	90	15	32	75	4.0	6.0	3.5
204E------------ Cushing	VIe	---	---	---	---	4.0	6.0	3.5
207B------------ Nymore	IVs	45	8	---	40	2.5	3.7	2.5
207C------------ Nymore	IVs	40	6	---	35	2.0	3.0	2.4
260------------- Duelm	IVs	70	10	16	60	4.0	6.0	2.5
261------------- Isan	IVw	60	10	20	55	2.8	4.2	3.0
292------------- Alstad	IIe	95	14	30	75	4.5	6.7	3.6
325------------- Prebish	IVw	65	12	22	60	3.5	---	3.5
341A------------ Arvilla	IIIs	55	8	18	45	2.5	3.7	2.0

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Kentucky bluegrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
341B------------ Arvilla	IIIe	55	8	16	35	2.0	3.0	1.5
341C------------ Arvilla	IVe	45	6	---	25	1.5	2.3	1.5
374B------------ Rockwood	IIe	95	14	---	70	4.0	6.0	3.0
374C------------ Rockwood	IIIe	85	13	---	65	3.7	5.5	3.0
374D------------ Rockwood	IVe	70	10	---	60	3.5	5.2	2.6
375------------- Forada	IIw	75	12	---	70	3.0	4.5	2.5
402C, 402E------ Sioux	VIs	---	---	---	---	2.0	3.0	1.5
406B------------ Dorset	IIIs	50	10	16	55	2.5	3.7	2.0
406C------------ Dorset	IVe	50	9	14	40	2.0	3.0	1.5
413------------- Osakis	IIIs	60	10	18	65	2.8	4.2	2.0
421B------------ Ves	IIe	115	17	32	80	5.5	8.2	3.0
421C------------ Ves	IIIe	100	16	28	75	4.5	6.7	3.0
446------------- Normania	I	120	18	35	85	5.5	8.2	4.0
453B------------ DeMontreville	IIIs	72	10	---	60	3.0	4.5	2.0
453C------------ DeMontreville	IVe	60	8	---	50	2.5	3.7	1.6
454B, 454C------ Mahtomedi	IVs	25	5	---	30	2.1	3.1	1.2
454E------------ Mahtomedi	VIIs	---	---	---	---	---	---	0.8
458B, 458C------ Menahga	IVs	35	6	---	40	2.5	3.7	1.2
458E------------ Menahga	VIs	---	---	---	---	2.0	3.0	1.0
514------------- Tacoosh	IVw	60	12	---	---	---	---	3.0

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Kentucky bluegrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
540 Seelyeville	IVw	60	14	---	---	---	---	3.3
541 Rifle	IVw	60	11	---	---	---	---	3.0
543 Markey	IVw	60	12	---	---	---	---	3.0
544 Cathro	IVw	60	12	---	---	---	---	3.0
545 Rondeau	IVw	60	12	---	---	---	---	3.0
565 Eckvoll	IIIs	75	10	---	65	2.5	3.7	2.8
571 Coriff	IIw	85	17	30	80	4.0	6.0	3.5
572 Lowlein	I	85	17	30	70	4.0	6.0	3.5
582 Roliss	IIw	90	18	30	75	3.5	5.3	3.5
701 Runeberg	IIIw	70	13	---	65	---	---	3.0
703 Paddock	IIw	80	15	---	70	3.0	4.5	3.0
720B Blowers	IIe	100	15	18	75	4.0	6.0	3.0
800B		75	12	---	66	3.9	5.2	2.6
Kandota	IIe							
Dorset	IIIe							
800C Kandota-Dorset	IVe	68	12	---	57	3.4	5.1	2.4
800E Kandota-Dorset	VIe	---	---	---	---	3.3	5.0	2.6
808		88	14	---	73	4.8	7.2	3.3
Wykeham	IIe							
Runebert	IIw							
823		---	---	---	---	---	---	---
Hangaard	IVw							
Sioux	VIs							

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Kentucky bluegrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
824C------------		45	7	---	45	2.5	3.7	2.0
Dorset---------	IVe							
Sioux----------	VIs							
824E------------ Dorset-Sioux	VIe	---	---	---	---	---	---	---
825-------------		105	16	---	80	4.0	6.0	4.0
Gonvick--------	I							
Flom-----------	IIw							
873-------------		70	14	25	67	3.7	5.5	3.3
Prebish--------	IVw							
Nokay----------	IIw							
928B------------		70	11	---	59	3.7	5.5	2.8
Cushing--------	IIe							
DeMontreville--	IIIs							
Mahtomedi------	IVs							
928C------------		60	10	---	54	3.4	5.1	2.5
Cushing--------	IIIe							
DeMontreville--	IVe							
Mahtomedi------	IVs							
928E------------		---	---	---	---	---	---	1.7
Cushing--------	VIIe							
DeMontreville--	VIIe							
Mahtomedi------	VIIs							
967C------------ Waukon-Langhei	IIIe	80	10	20	62	3.2	4.8	2.6
967D------------ Waukon-Langhei	VIe	---	---	---	---	---	---	1.6
1015. Psamments								
1029**. Pits								
1054------------ Prebish and Histosols	VIIIw	---	---	---	---	---	---	---
1055------------ Aquolls and Histosols	VIIIw	---	---	---	---	---	---	---

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Kentucky bluegrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
1926------------ Bowstring-Aquents	VIw	---	---	---	---	---	---	---
1927------------ Clotho	IIw	75	15	---	70	3.0	4.5	3.0
1932------------ Runeberg	IIw	80	14	---	75	4.5	6.8	6.8
1943------------ Roscommon	IVw	50	8	---	55	2.0	3.0	1.5
1956------------ Staples	IIIw	55	13	---	50	2.0	3.0	3.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
7A, 7B Hubbard	2S	Slight	Moderate	Moderate	Slight	Bur oak	40	26	Red pine, white spruce, eastern white pine, jack pine, northern red oak.
						Red pine	56	91	
						Jack pine	58	82	
						White spruce	54	105	
						Quaking aspen	68	78	
38B, 38C Waukon	4A	Slight	Slight	Slight	Slight	Northern red oak	60	51	Red pine, eastern white pine, white spruce, jack pine, northern red oak.
						Sugar maple	58	41	
						American elm	70	---	
						Quaking aspen	72	84	
						Green ash	62	54	
						American basswood	80	80	
53B, 53C Kandota	4A	Slight	Slight	Slight	Slight	Northern red oak	68	63	Eastern white pine, northern red oak, white spruce, red pine.
						Red pine	60	---	
						Quaking aspen	75	88	
						White spruce	61	121	
						American basswood	70	66	
						Sugar maple	58	41	
						American elm	65	---	
53D Kandota	4R	Moderate	Moderate	Slight	Slight	Northern red oak	68	63	Eastern white pine, northern red oak, white spruce, red pine.
						Red pine	60	---	
						Quaking aspen	75	88	
						White spruce	61	121	
						American basswood	70	66	
						Sugar maple	58	41	
						American elm	65	---	
82B, 82C Redeye	2S	Slight	Slight	Moderate	Slight	Northern red oak	45	28	Red pine, white spruce, eastern white pine, jack pine.
						Jack pine	61	87	
						Quaking aspen	78	91	
						Bigtooth aspen	75	88	
						Bur oak	42	28	
						American elm	---	---	
121 Wykeham	4A	Slight	Slight	Slight	Slight	Northern red oak	68	63	Eastern white pine, red pine, northern red oak, white spruce.
						American elm	---	---	
						Quaking aspen	70	81	
						White spruce	61	121	
						American basswood	70	66	
						Sugar maple	58	41	
139B Huntersville	2S	Slight	Slight	Moderate	Slight	Northern red oak	45	28	Red pine, white spruce, eastern white pine, jack pine.
						Jack pine	58	82	
						Quaking aspen	76	89	
						Bur oak	42	28	
						Bigtooth aspen	75	88	
142 Nokay	4A	Slight	Slight	Slight	Slight	Northern red oak	65	59	White spruce, red pine.
						Quaking aspen	75	88	
						Sugar maple	60	43	
						American basswood	65	59	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
144B, 144C------ Flak	3D	Slight	Slight	Slight	Moderate	Northern red oak----	64	57	Red pine, white spruce, eastern white pine, northern red oak, green ash.
						White oak-----------	60	51	
						Quaking aspen-------	75	88	
						American elm--------	---	---	
						American basswood---	60	51	
158B, 158C------ Zimmerman	2S	Slight	Moderate	Moderate	Slight	Northern red oak----	48	31	Red pine, eastern white pine, jack pine, balsam fir.
						Paper birch---------	67	77	
						Quaking aspen-------	77	90	
						Eastern white pine--	76	168	
						Bur oak-------------	---	---	
163B------------ Brainerd	4A	Slight	Slight	Slight	Slight	Northern red oak----	64	57	Red pine, white spruce.
						Quaking aspen-------	70	81	
						American basswood---	60	51	
						American elm--------	---	---	
						White oak-----------	60	51	
169B------------ Braham	3S	Slight	Moderate	Moderate	Slight	Northern red oak----	56	44	Red pine, eastern white pine, white spruce.
						Quaking aspen-------	75	88	
						Black cherry--------	57	36	
						American basswood---	55	42	
170------------- Blomford	3W	Slight	Moderate	Moderate	Moderate	Black ash-----------	65	47	White spruce, jack pine, eastern white pine.
						Quaking aspen-------	74	86	
						American elm--------	60	---	
180------------- Gonvick	4A	Slight	Slight	Slight	Slight	Northern red oak----	64	57	Red pine, white spruce, eastern white pine, northern red oak, green ash.
						Quaking aspen-------	85	100	
						American basswood---	81	82	
						Sugar maple---------	57	40	
						Green ash-----------	72	69	
						American elm--------	85	---	
200B, 200C------ Holdingford	4A	Slight	Slight	Slight	Slight	Northern red oak----	61	53	Red pine, white spruce, eastern white pine, northern red oak.
						Quaking aspen-------	74	86	
						Bur oak-------------	57	40	
						Slippery elm--------	70	---	
						American elm--------	65	---	
						American basswood---	61	53	
						Sugar maple---------	57	40	
202------------- Meehan	3W	Slight	Moderate	Moderate	Moderate	Northern red oak----	66	48	Eastern white pine, jack pine, white spruce, red pine, red maple.
						Jack pine-----------	66	96	
						Red pine------------	70	128	
						Quaking aspen-------	75	88	
						Paper birch---------	67	77	
204B, 204C------ Cushing	4A	Slight	Slight	Slight	Slight	Northern red oak----	64	57	Eastern white pine, northern red oak, white spruce.
						Sugar maple---------	60	43	
						American basswood---	60	51	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
204E Cushing	4R	Moderate	Moderate	Slight	Slight	Northern red oak	64	57	Eastern white pine, northern red oak, white spruce, red pine.
						Sugar maple	60	43	
						American basswood	60	51	
207B, 207C Nymore	3S	Slight	Slight	Moderate	Slight	Northern red oak	55	42	Red pine, white spruce, jack pine.
						Jack pine	60	85	
						Red pine	55	88	
						Bur oak	---	---	
						White spruce	55	107	
260 Duelm	3S	Slight	Moderate	Moderate	Moderate	Northern red oak	55	42	Eastern white pine, red pine, white spruce, jack pine.
						Jack pine	58	82	
						Quaking aspen	80	94	
						Red pine	60	101	
						American elm	---	---	
292 Alstad	4A	Slight	Slight	Slight	Slight	Northern red oak	62	54	Eastern white pine, white spruce, northern red oak.
						Red maple	65	40	
						American basswood	60	51	
						American elm	---	---	
						Quaking aspen	68	78	
325 Prebish	3W	Slight	Moderate	Moderate	Severe	Black ash	65	47	Black ash, black spruce, tamarack.
						Green ash	66	60	
						Slippery elm	58	---	
						Quaking aspen	75	88	
374B, 374C Rockwood	4A	Slight	Slight	Slight	Slight	Northern red oak	61	53	Red pine, eastern white pine, jack pine, northern red oak.
						White oak	55	42	
						Bur oak	54	38	
						Green ash	65	59	
						Quaking aspen	75	88	
						American basswood	58	48	
374D Rockwood	3R	Moderate	Moderate	Slight	Slight	Northern red oak	61	53	Red pine, eastern white pine, northern red oak.
						White oak	55	42	
						Bur oak	54	38	
						Green ash	65	59	
						Quaking aspen	75	88	
						American basswood	58	48	
406B, 406C Dorset	2S	Slight	Slight	Moderate	Slight	Northern red oak	50	34	Green ash, eastern white pine, white spruce, red pine, northern red oak.
						Bur oak	45	30	
						Quaking aspen	60	64	
						Green ash	50	34	
453B, 453C DeMontreville	4S	Slight	Slight	Moderate	Slight	Northern red oak	66	60	Red pine, white spruce, jack pine, northern red oak.
						American basswood	60	51	
						Quaking aspen	72	84	
						Paper birch	62	68	
454B, 454C Mahtomedi	2S	Slight	Moderate	Moderate	Slight	Northern red oak	48	31	Red pine, jack pine, eastern white pine, white spruce.
						Red pine	55	88	
						Eastern white pine	55	106	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
454E Mahtomedi	2R	Moderate	Moderate	Moderate	Slight	Northern red oak	48	31	Red pine, jack pine, eastern white pine, white spruce.
						Red pine	55	88	
						Eastern white pine	50	106	
458B, 458C Menahga	2S	Slight	Moderate	Moderate	Slight	Northern red oak	57	80	Red pine, white spruce, eastern white pine, jack pine.
						Red pine	57	80	
						Jack pine	57	80	
						Eastern white pine	58	115	
						Quaking aspen	65	72	
						Paper birch	57	60	
458E Menahga	2R	Moderate	Moderate	Moderate	Slight	Northern red oak	50	34	Red pine, white spruce, eastern white pine, jack pine.
						Red pine	52	80	
						Jack pine	57	80	
						Eastern white pine	58	115	
						Quaking aspen	65	72	
						Paper birch	57	60	
514 Tacoosh	4W	Slight	Severe	Severe	Severe	Black spruce	35	50	Black spruce, tamarack.
						Black ash	---	---	
						Tamarack	60	---	
						Quaking aspen	---	---	
540 Seelyeville	4W	Slight	Severe	Severe	Severe	Black spruce	35	50	Black spruce, tamarack, northern white-cedar.
						Tamarack	59	---	
						Black ash	56	39	
541 Rifle	4W	Slight	Severe	Severe	Severe	Black spruce	35	50	Black spruce, tamarack, northern white-cedar.
						Tamarack	50	---	
						Black ash	51	35	
543 Markey	4W	Slight	Severe	Severe	Severe	Black spruce	35	50	Black spruce, tamarack, northern white-cedar.
						Quaking aspen	45	32	
						Tamarack	---	---	
						Black ash	---	---	
544 Cathro	4W	Slight	Severe	Severe	Severe	Black spruce	35	50	Black spruce, tamarack, northern white-cedar.
						Black ash	55	37	
						Tamarack	55	---	
565 Eckvoll	3A	Slight	Slight	Slight	Slight	Northern red oak	55	42	Red pine, northern red oak, white spruce.
						Quaking aspen	70	81	
						Bur oak	45	30	
						American basswood	60	51	
701 Runeberg	3W	Slight	Moderate	Moderate	Severe	Black ash	61	44	Black ash, black spruce, green ash, tamarack.
						Green ash	64	57	
						Quaking aspen	79	93	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
703------------- Paddock	4W	Slight	Moderate	Moderate	Moderate	Northern red oak----	60	51	White spruce, green ash, red pine.
						White spruce--------	50	96	
						Quaking aspen-------	72	84	
						Black ash-----------	66	48	
						American elm--------	50	---	
						White oak-----------	57	46	
						Green ash-----------	65	---	
720B------------ Blowers	4A	Slight	Slight	Slight	Slight	Northern red oak----	68	63	Red pine, white spruce, eastern white pine, northern red oak, green ash.
						American basswood---	75	73	
						Quaking aspen-------	70	81	
						American elm--------	55	---	
						White oak-----------	55	42	
						Red pine------------	67	120	
800B**, 800C**:									
Kandota--------	4A	Slight	Slight	Slight	Slight	Northern red oak----	68	63	Eastern white pine, northern red oak, white spruce, red pine.
						Quaking aspen-------	75	88	
						White spruce--------	61	121	
						American basswood---	70	66	
						Sugar maple---------	58	41	
						American elm--------	65	---	
Dorset---------	2S	Slight	Slight	Moderate	Slight	Northern red oak----	50	34	Eastern white pine, white spruce, red pine.
						Bur oak-------------	45	30	
						Quaking aspen-------	60	64	
						Green ash-----------	50	34	
800E**:									
Kandota--------	4R	Moderate	Moderate	Slight	Slight	Northern red oak----	68	63	Eastern white pine, northern red oak, white spruce, red pine.
						Quaking aspen-------	75	88	
						White spruce--------	61	121	
						American basswood---	70	66	
						Sugar maple---------	58	41	
						American elm--------	65	---	
Dorset---------	2R	Moderate	Moderate	Severe	Slight	Northern red oak----	50	34	Eastern white pine, white spruce, red pine.
						Bur oak-------------	45	30	
						Quaking aspen-------	60	64	
						Green ash-----------	50	34	
808**:									
Wykeham--------	4A	Slight	Slight	Slight	Slight	Northern red oak----	68	63	Eastern white pine, red pine, northern red oak, white spruce.
						American elm--------	---	---	
						Quaking aspen-------	70	81	
						White spruce--------	61	121	
						American basswood---	70	66	
						Sugar maple---------	58	41	
Runeberg-------	3W	Slight	Moderate	Moderate	Moderate	Black ash-----------	61	44	Black ash, black spruce, green ash, tamarack.
						Green ash-----------	64	57	
						Quaking aspen-------	80	94	
824C**:									
Dorset---------	2S	Slight	Slight	Moderate	Slight	Northern red oak----	50	34	Eastern white pine, white spruce, red pine.
						Bur oak-------------	45	30	
						Quaking aspen-------	60	64	
						Green ash-----------	50	34	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
824C**: Sioux.									
824E**: Dorset	2R	Moderate	Moderate	Severe	Slight	Northern red oak	50	34	Eastern white pine, white spruce, red pine.
						Bur oak	45	30	
						Quaking aspen	60	64	
						Green ash	50	34	
Sioux.									
825**: Gonvick	4A	Slight	Slight	Slight	Slight	Northern red oak	64	57	Red pine, white spruce, eastern white pine.
						Quaking aspen	85	100	
						American basswood	81	82	
						Sugar maple	57	40	
						Green ash	72	69	
						American elm	85	---	
Flom.									
873**: Prebish	3W	Slight	Moderate	Moderate	Severe	Black ash	65	47	Black ash, black spruce, tamarack.
						Green ash	66	60	
						Quaking aspen	75	88	
						Slippery elm	58	---	
Nokay	4A	Slight	Slight	Slight	Slight	Northern red oak	65	59	White spruce, red pine.
						Quaking aspen	75	88	
						Sugar maple	60	43	
						American basswood	65	59	
928B**, 928C**: Cushing	4A	Slight	Slight	Slight	Slight	Northern red oak	64	57	Eastern white pine, white spruce, red pine, northern red oak.
						Sugar maple	60	43	
						American basswood	60	51	
						American elm	---	---	
						Silver maple	---	---	
						Green ash	70	60	
						White oak	55	42	
DeMontreville	4S	Slight	Slight	Moderate	Slight	Northern red oak	66	60	Red pine, white spruce, jack pine.
						Paper birch	62	68	
						American basswood	60	51	
						Quaking aspen	72	84	
Mahtomedi	2S	Slight	Moderate	Moderate	Slight	Northern red oak	48	31	Red pine, jack pine, eastern white pine, white spruce.
						Red pine	55	88	
						Eastern white pine	55	106	
						American basswood	50	34	
928E**: Cushing	4R	Moderate	Moderate	Slight	Slight	Northern red oak	64	57	Eastern white pine, white spruce, red pine, northern red oak.
						Sugar maple	60	43	
						American basswood	---	---	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
928E**:									
DeMontreville	4R	Moderate	Moderate	Moderate	Slight	Northern red oak	66	60	Red pine, white spruce, jack pine, northern red oak.
						American basswood	60	51	
						Quaking aspen	72	84	
						Paper birch	62	68	
Mahtomedi	2R	Moderate	Moderate	Moderate	Slight	Northern red oak	48	31	Red pine, jack pine, eastern white pine, white spruce.
						Red pine	55	88	
						Eastern white pine	55	106	
						American basswood	50	34	
967C**:									
Waukon	4A	Slight	Slight	Slight	Slight	Northern red oak	60	51	Red pine, eastern white pine, white spruce, jack pine, northern red oak.
						Sugar maple	58	41	
						American elm	70	---	
						Quaking aspen	72	84	
						Green ash	62	54	
						American basswood	80	80	
Langhei.									
967D**:									
Waukon	4R	Moderate	Moderate	Slight	Slight	Northern red oak	60	51	Red pine, eastern white pine, white spruce, jack pine.
						Sugar maple	58	41	
						American elm	70	---	
						Quaking aspen	72	84	
						Green ash	62	54	
						American basswood	80	80	
Langhei.									
1054**:									
Prebish	3W	Slight	Moderate	Moderate	Severe	Black ash	65	40	Black ash, black spruce, tamarack.
						Green ash	66	60	
						Slippery elm	58	---	
						Quaking aspen	75	88	
Histosols.									
1932 Runeberg	3W	Slight	Moderate	Moderate	Moderate	Black ash	61	44	Black ash, black spruce, green ash, tamarack.
						Green ash	64	57	
						Quaking aspen	80	94	
						White oak	55	42	
1943 Roscommon	3W	Slight	Severe	Severe	Severe	Black ash	55	38	Black spruce, balsam fir, northern white-cedar.
						Black spruce	35	50	
						Tamarack	50	---	
						Quaking aspen	78	91	
						Silver maple	---	---	
1956 Staples	2W	Slight	Moderate	Moderate	Slight	Northern red oak	45	28	White spruce, black spruce, balsam fir, green ash, black ash.
						Quaking aspen	71	82	
						Black ash	45	30	
						Jack pine	60	85	
						White oak	---	---	
						American elm	---	---	

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
7A, 7B Hubbard	---	Eastern redcedar, Siberian peashrub, lilac, Siberian crabapple, Manchurian crabapple.	Red pine, jack pine, Russian-olive, green ash.	Eastern white pine, Siberian elm.	---
36 Flom	---	Siberian peashrub, lilac, northern white-cedar.	Manchurian crabapple, Russian-olive, blue spruce, white spruce.	Green ash	Eastern cottonwood.
38B, 38C Waukon	---	Siberian peashrub, redosier dogwood, lilac, Amur maple.	Northern white-cedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, eastern white pine, silver maple.	Eastern cottonwood.
53B, 53C, 53D Kandota	---	Amur maple, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, white spruce, Manchurian crabapple, blue spruce.	Eastern white pine, green ash, red pine.	Eastern cottonwood, silver maple.
75 Bluffton	---	Redosier dogwood, black spruce.	Tamarack, black ash.	Golden willow, white willow.	---
82B, 82C Redeye	---	Amur maple, lilac, Siberian peashrub.	Eastern white pine, white spruce, red pine, blue spruce, Harbin pear.	Green ash, jack pine.	---
111 Hangaard	---	Siberian peashrub, lilac, northern white-cedar.	Manchurian crabapple, black spruce, Russian-olive, white spruce.	Green ash, golden willow.	Eastern cottonwood.
121 Wykeham	---	Lilac, redosier dogwood, Siberian peashrub.	White spruce, black spruce, eastern redcedar.	Norway spruce, eastern white pine, jack pine, red pine, green ash.	---
127A, 127B Sverdrup	---	Eastern redcedar, Siberian crabapple, common chokecherry, lilac, American plum, Siberian peashrub, silver buffaloberry.	Green ash, bur oak, red pine, Russian-olive, green ash, silver maple.	---	---

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
139B-------------- Huntersville	---	Amur maple, lilac, Siberian peashrub.	White spruce, blue spruce, Harbin pear.	Eastern white pine, green ash, red pine, jack pine.	---
142--------------- Nokay	---	Siberian peashrub, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Red pine, eastern white pine, green ash.	Silver maple, eastern cottonwood.
144B, 144C-------- Flak	---	Amur maple, northern white-cedar, Siberian peashrub, lilac.	Manchurian crabapple, eastern redcedar, white spruce.	Eastern white pine, jack pine, green ash.	---
158B, 158C-------- Zimmerman	---	Eastern redcedar, lilac, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Jack pine, red pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
163B-------------- Brainerd	---	Northern white-cedar, Amur maple, Siberian peashrub, lilac.	Eastern redcedar, Manchurian crabapple, white spruce, silver maple.	Eastern white pine, green ash, jack pine.	---
169B-------------- Braham	---	American cranberrybush, lilac, Siberian peashrub, Amur maple.	Eastern redcedar, red pine, blue spruce, white spruce.	Norway spruce, jack pine, green ash, eastern white pine.	---
170--------------- Blomford	---	Lilac, Siberian peashrub, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce, Siberian crabapple.	Eastern white pine, green ash.	Silver maple.
180--------------- Gonvick	---	Siberian peashrub, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Red pine, eastern white pine, green ash.	Eastern cottonwood, silver maple.
183--------------- Dassel	---	Redosier dogwood, American plum.	White spruce, northern white-cedar, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
200B, 200C-------- Holdingford	---	Amur maple, lilac, Siberian peashrub.	White spruce, red pine, blue spruce, eastern redcedar, northern red oak.	Eastern white pine, green ash, jack pine, silver maple.	---
202--------------- Meehan	---	Lilac, Siberian peashrub, redosier dogwood.	Eastern redcedar, white spruce, northern red oak.	Eastern white pine, red pine, jack pine, Norway spruce, green ash.	Eastern cottonwood.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
204B, 204C, 204E-- Cushing	---	Redosier dogwood, Siberian peashrub, lilac, Amur maple.	Northern white-cedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, silver maple.	---
207B, 207C-------- Nymore	---	Eastern redcedar, lilac, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Jack pine, red pine, Russian-olive, green ash.	Eastern white pine, Siberian elm.	---
260--------------- Duelm	---	Siberian peashrub, lilac, redosier dogwood.	White spruce, blue spruce.	Norway spruce, green ash, jack pine, eastern white pine, red pine, jack pine.	---
261--------------- Isan	---	Lilac, Siberian peashrub, redosier dogwood.	Black spruce, white spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple, eastern cottonwood.
292--------------- Alstad	---	Siberian peashrub, redosier dogwood, lilac.	White spruce, blue spruce.	Norway spruce, jack pine, red pine, eastern white pine, green ash.	---
325--------------- Prebish	---	Redosier dogwood, black spruce.	Tamarack, black ash.	Golden willow, white willow.	Silver maple.
341A, 341B, 341C-- Arvilla	Lilac--------------	Russian-olive, Siberian crabapple, eastern redcedar, Siberian peashrub, common chokecherry.	Honeylocust, green ash, ponderosa pine.	Siberian elm------	---
374B, 374C, 374D-- Rockwood	---	Amur maple, northern white-cedar, lilac, Siberian peashrub.	White spruce, Manchurian crabapple, white spruce.	Red pine, green ash, eastern white pine.	---
375--------------- Forada	---	Lilac, Siberian peashrub, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine	Silver maple, eastern cottonwood.
402C, 402E. Sioux					

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
406B, 406C-------- Dorset	Silver buffaloberry, Siberian peashrub, lilac.	Siberian crabapple, Manchurian crabapple.	Jack pine, Russian-olive, eastern white pine, red pine, green ash.	---	---
413--------------- Osakis	---	Lilac, redosier dogwood, Siberian peashrub.	White spruce, blue spruce.	Red pine, jack pine, green ash, eastern white pine.	Eastern cottonwood, silver maple.
421B, 421C-------- Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Northern white-cedar, Amur maple, blue spruce, Russian-olive.	Green ash, eastern white pine.	Eastern cottonwood, silver maple.
446--------------- Normania	---	Lilac, redosier dogwood.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Eastern white pine, Austrian pine, green ash.	Silver maple, eastern cottonwood.
453B, 453C-------- DeMontreville	---	Siberian peashrub, lilac, Amur maple.	Red pine, blue spruce, white spruce.	Eastern white pine, Norway spruce, jack pine, green ash, silver maple.	---
454B, 454C, 454E-- Mahtomedi	---	Eastern redcedar, lilac, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
458B, 458C, 458E-- Menahga	---	Lilac, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
514--------------- Tacoosh	---	Amur privet, Siberian peashrub.	White spruce, northern white-cedar.	Green ash, Siberian crabapple, eastern white pine.	---
540--------------- Seelyeville	---	---	Amur maple, black spruce.	Golden willow, white willow, black ash.	Imperial Carolina poplar.
541--------------- Rifle	Common ninebark---	---	Amur maple, black spruce.	Golden willow, white willow, black ash.	Imperial Carolina poplar.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
543 Markey	Common ninebark	---	Amur maple, black spruce.	Golden willow, white willow, black ash.	Imperial Carolina poplar.
544 Cathro	Common ninebark	Black spruce, redosier dogwood.	Amur maple, black spruce.	Golden willow, white willow, black ash.	Imperial Carolina poplar.
545 Rondeau	---	Gray dogwood, common ninebark, medium purple willow, northern white-cedar.	Amur maple, black spruce, white spruce.	Black ash, laurel willow.	Eastern cottonwood.
565 Eckvoll	---	Lilac, redosier dogwood, Siberian peashrub.	Blue spruce, white spruce, northern white-cedar.	Eastern white pine, jack pine, red pine, green ash.	---
571 Coriff	---	Siberian peashrub, lilac, northern white-cedar.	Eastern redcedar, bur oak, white spruce, Siberian crabapple.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
572 Lowlein	---	Lilac, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Amur maple.	Eastern white pine, Austrian pine, green ash.	Silver maple, eastern cottonwood.
582 Roliss	---	Siberian peashrub, lilac, northern white-cedar.	Eastern redcedar, Manchurian crabapple, blue spruce, Russian-olive, white spruce, bur oak.	Green ash, golden willow.	Eastern cottonwood.
701 Runeberg	---	Black spruce, lilac, redosier dogwood.	Black ash, tamarack, northern white-cedar.	Golden willow, white willow, green ash.	Eastern cottonwood.
703 Paddock	---	Amur maple, lilac, Siberian peashrub.	Northern white-cedar, white spruce, eastern redcedar, white spruce, Manchurian crabapple.	Eastern white pine, jack pine, green ash, silver maple.	---
720B Blowers	---	Northern white-cedar, Amur maple, lilac, Siberian peashrub.	White spruce, Russian-olive, Manchurian crabapple.	Green ash, eastern white pine, red pine, silver maple.	---

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
800B*, 800C*, 800E*:					
Kandota---------	---	Amur maple, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, white spruce, Manchurian crabapple, blue spruce.	Eastern white pine, green ash, red pine.	Eastern cottonwood.
Dorset----------	Silver buffaloberry, Siberian peashrub, lilac.	Siberian crabapple, Manchurian crabapple.	Jack pine, Russian-olive, eastern white pine, red pine, green ash.	---	---
808*:					
Wykeham----------	---	Lilac, redosier dogwood, Siberian peashrub.	White spruce, blue spruce, eastern redcedar.	Norway spruce, eastern white pine, jack pine, red pine, green ash.	---
Runeberg---------	---	Lilac, Siberian peashrub, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
823*:					
Hangaard---------	---	Siberian peashrub, lilac, northern white-cedar.	Eastern redcedar, Manchurian crabapple, blue spruce, Russian-olive, white spruce, bur oak.	Green ash, golden willow.	Eastern cottonwood.
Sioux.					
824C*, 824E*:					
Dorset-----------	Silver buffaloberry, Siberian peashrub, lilac.	Eastern redcedar, Siberian crabapple, Manchurian crabapple.	Jack pine, Russian-olive, eastern white pine, red pine, green ash.	---	---
Sioux.					
825*:					
Gonvick----------	---	Siberian peashrub, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Norway spruce, jack pine, red pine, eastern white pine, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
825*:					
Flom	---	Siberian peashrub, lilac, northern white-cedar.	Eastern redcedar, Manchurian crabapple, Russian-olive, blue spruce, white spruce, bur oak.	Green ash, golden willow.	Eastern cottonwood.
873*:					
Prebish	---	Siberian peashrub, lilac, redosier dogwood.	Northern white-cedar, white spruce, Norway spruce, black spruce.	Eastern white pine, green ash.	Silver maple.
Nokay	---	Siberian peashrub, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Norway spruce, jack pine, red pine, eastern white pine, green ash.	---
928B*, 928C*, 928E*:					
Cushing	---	Redosier dogwood, Siberian peashrub, lilac, Amur maple.	Northern white-cedar, eastern redcedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, eastern white pine.	---
DeMontreville	---	Siberian peashrub, lilac, Amur maple.	Eastern redcedar, red pine, blue spruce, white spruce.	Eastern white pine, Norway spruce, jack pine, green ash.	---
Mahtomedi	---	Eastern redcedar, lilac, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
967C*, 967D*:					
Waukon	---	Siberian peashrub, redosier dogwood, lilac, Amur maple.	Northern white-cedar, eastern redcedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, eastern white pine.	Eastern cottonwood.
Langhei	Lilac, Siberian peashrub.	Eastern redcedar, ponderosa pine, Russian-olive, American plum.	Siberian elm, green ash.	---	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1015. Psamments					
1029*. Pits					
1054*: Prebish.					
Histosols.					
1055*: Aquolls.					
Histosols.					
1926*: Bowstring.					
Aquents.					
1927 Clotho	---	Siberian peashrub, lilac, northern white-cedar.	Russian-olive, eastern redcedar, white spruce, blue spruce, Manchurian crabapple.	Green ash, golden willow.	Eastern cottonwood.
1932 Runeberg	---	Lilac, Siberian peashrub, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
1943 Roscommon	---	Lilac, Siberian peashrub, redosier dogwood.	Northern white-cedar, Amur maple, white spruce.	Green ash, eastern white pine, Norway spruce.	Imperial Carolina poplar.
1956. Staples					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
7A Hubbard	Slight	Slight	Slight	Slight	Severe: droughty.
7B Hubbard	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
36 Flom	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
38B Waukon	Slight	Slight	Moderate: slope.	Slight	Slight.
38C Waukon	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
53B Kandota	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
53C Kandota	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
53D Kandota	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
75 Bluffton	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
82B Redeye	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
82C Redeye	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
111 Hangaard	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: droughty.
121 Wykeham	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
127A Sverdrup	Slight	Slight	Slight	Slight	Moderate: droughty.
127B Sverdrup	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
139B Huntersville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
142 Nokay	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
144B Flak	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
144C Flak	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
158B Zimmerman	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
158C Zimmerman	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
163B Brainerd	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Moderate: wetness.	Moderate: wetness, droughty.
169B Braham	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
170 Blomford	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
180 Gonvick	Slight	Slight	Moderate: slope.	Slight	Slight.
183 Dassel	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
200B Holdingford	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
200C Holdingford	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
202 Meehan	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.	Moderate: wetness, droughty.
204B Cushing	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
204C Cushing	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
204E Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
207B Nymore	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Severe: droughty.
207C Nymore	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Severe: droughty.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
260 Duelm	Moderate: wetness.	Moderate: wetness.	Moderate: small stones, wetness.	Slight	Moderate: droughty.
261 Isan	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
292 Alstad	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
325 Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
341A Arvilla	Slight	Slight	Slight	Slight	Moderate: droughty.
341B Arvilla	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
341C Arvilla	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
374B Rockwood	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
374C Rockwood	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
374D Rockwood	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
375 Forada	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, droughty.
402C Sioux	Slight	Slight	Severe: slope.	Slight	Severe: droughty.
402E Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: droughty, slope.
406B Dorset	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
406C Dorset	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
413 Osakis	Slight	Slight	Slight	Slight	Moderate: droughty.
421B Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
421C Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
446------------------ Normania	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
453B----------------- DeMontreville	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones.	Moderate: too sandy.	Moderate: droughty.
453C----------------- DeMontreville	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
454B----------------- Mahtomedi	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Moderate: small stones.
454C----------------- Mahtomedi	Moderate: slope, small stones.	Moderate: slope, too sandy.	Severe: slope, small stones.	Moderate: too sandy.	Moderate: small stones.
454E----------------- Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: slope.
458B----------------- Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
458C----------------- Menahga	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: slope, droughty.
458E----------------- Menahga	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope, too sandy.	Severe: slope.
514------------------ Tacoosh	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
540------------------ Seelyeville	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
541------------------ Rifle	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
543------------------ Markey	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
544------------------ Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
545------------------ Rondeau	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
565------------------ Eckvoll	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: slope, small stones.	Moderate: too sandy.	Slight.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
571 Coriff	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
572 Lowlein	Slight	Slight	Moderate: small stones.	Slight	Slight.
582 Roliss	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
701 Runeberg	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
703 Paddock	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: large stones, wetness.
720B Blowers	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Slight	Moderate: large stones.
800B*:					
Kandota	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
Dorset	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
800C*:					
Kandota	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
Dorset	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
800E*:					
Kandota	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Dorset	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
808*:					
Wykeham	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
Runeberg	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
823*:					
Hangaard	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: droughty.
Sioux	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
824C*:					
Dorset	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
824E*:					
Dorset	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: droughty, slope.
825*:					
Gonvick	Slight	Slight	Moderate: slope.	Slight	Slight.
Flom	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
873*:					
Prebish	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Nokay	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
928B*:					
Cushing	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
DeMontreville	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones.	Moderate: too sandy.	Moderate: droughty.
Mahtomedi	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Moderate: small stones.
928C*:					
Cushing	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
DeMontreville	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
Mahtomedi	Moderate: slope, small stones.	Moderate: slope, too sandy.	Severe: slope, small stones.	Moderate: too sandy.	Moderate: small stones.
928E*:					
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
928E*:					
DeMontreville	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: slope.
967C*:					
Waukon	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Langhei	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
967D*:					
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
1015. Psamments					
1029*. Pits					
1054*:					
Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Histosols.					
1055*:					
Aquolls.					
Histosols.					
1926*:					
Bowstring	Severe: flooding, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, flooding.	Severe: wetness, excess humus.	Severe: wetness, flooding, excess humus.
Aquents.					
1927 Clotho	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1932 Runeberg	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1943 Roscommon	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1956 Staples	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
7A, 7B------------- Hubbard	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
36----------------- Flom	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
38B---------------- Waukon	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
38C---------------- Waukon	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
53B---------------- Kandota	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
53C---------------- Kandota	Fair	Good	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
53D---------------- Kandota	Poor	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
75----------------- Bluffton	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
82B, 82C----------- Redeye	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
111---------------- Hangaard	Poor	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
121---------------- Wykeham	Good	Good	Good	Good	Fair	Poor	Poor	Good	Good	Poor.
127A, 127B--------- Sverdrup	Fair	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	Fair	Poor.
139B--------------- Huntersville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
142---------------- Nokay	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
144B--------------- Flak	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
144C--------------- Flak	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
158B, 158C--------- Zimmerman	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
163B--------------- Brainerd	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
169B--------------- Braham	Fair	Good	Good	Fair	Good	Very poor.	Very poor.	Fair	Good	Very poor.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
170 Blomford	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Poor.
180 Gonvick	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
183 Dassel	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
200B Holdingford	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
200C Holdingford	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
202 Meehan	Poor	Fair	Good	Fair	Fair	Fair	Poor	Poor	Fair	Poor.
204B Cushing	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
204C Cushing	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
204E Cushing	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
207B, 207C Nymore	Poor	Fair	Fair	Poor	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
260 Duelm	Poor	Fair	Good	Fair	Good	Fair	Fair	Poor	Good	Fair.
261 Isan	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
292 Alstad	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
325 Prebish	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
341A, 341B Arvilla	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
341C Arvilla	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
374B Rockwood	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
374C Rockwood	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
374D Rockwood	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
375 Forada	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
402C Sioux	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
402E--------------- Sioux	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
406B--------------- Dorset	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
406C--------------- Dorset	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
413---------------- Osakis	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Poor	Poor.
421B--------------- Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
421C--------------- Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
446---------------- Normania	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
453B--------------- DeMontreville	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
453C--------------- DeMontreville	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
454B, 454C--------- Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
454E--------------- Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
458B, 458C--------- Menahga	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
458E--------------- Menahga	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
514---------------- Tacoosh	Poor	Fair	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
540---------------- Seelyeville	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
541---------------- Rifle	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
543---------------- Markey	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
544---------------- Cathro	Poor	Fair	Fair	Fair	Fair	Good	Good	Poor	Poor	Good.
545---------------- Rondeau	Fair	Fair	Poor	Poor	Very poor.	Good	Good	Fair	Very poor.	Good.
565---------------- Eckvoll	Poor	Fair	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
571---------------- Coriff	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
572---------------- Lowlein	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
582---------------- Roliss	Good	Good	Good	Fair	---	Good	Fair	Good	Fair	Fair.
701---------------- Runeberg	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
703---------------- Paddock	Fair	Good	Good	Fair	Fair	Good	Good	Fair	Fair	Fair.
720B--------------- Blowers	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
800B*:										
Kandota-----------	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
Dorset------------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
800C*:										
Kandota-----------	Fair	Good	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
Dorset------------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
800E*:										
Kandota-----------	Poor	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
Dorset------------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
808*:										
Wykeham-----------	Good	Good	Good	Good	Fair	Poor	Poor	Good	Good	Poor.
Runeberg----------	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
823*:										
Hangaard----------	Poor	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Sioux-------------	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
824C*:										
Dorset------------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Sioux-------------	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
824E*:										
Dorset------------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Sioux-------------	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
825*:										
Gonvick	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
Flom	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
873*:										
Prebish	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Nokay	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
928B*:										
Cushing	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
DeMontreville	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
928C*:										
Cushing	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
DeMontreville	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
928E*:										
Cushing	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
DeMontreville	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
967C*:										
Waukon	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Langhei	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
967D*:										
Waukon	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Langhei	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
1015. Psamments										
1029*. Pits										

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1054*:										
Prebish	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Histosols.										
1055*:										
Aquolls.										
Histosols.										
1926*:										
Bowstring	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Aquents.										
1927 Clotho	Good	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Fair.
1932 Runeberg	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
1943 Roscommon	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
1956 Staples	Poor	Fair	Fair	Good	Fair	Good	Good	Fair	Good	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
7A----------------- Hubbard	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
7B----------------- Hubbard	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Severe: droughty.
36----------------- Flom	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
38B---------------- Waukon	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength, frost action.	Slight.
38C---------------- Waukon	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
53B---------------- Kandota	Moderate: dense layer.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
53C---------------- Kandota	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
53D---------------- Kandota	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
75----------------- Bluffton	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
82B---------------- Redeye	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: droughty.
82C---------------- Redeye	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
111---------------- Hangaard	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Severe: droughty.
121---------------- Wykeham	Moderate: dense layer, wetness.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Moderate: large stones.
127A--------------- Sverdrup	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
127B--------------- Sverdrup	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
139B--------------- Huntersville	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Moderate: droughty.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
142----------- Nokay	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
144B---------- Flak	Moderate: dense layer.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: droughty.
144C---------- Flak	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
158B---------- Zimmerman	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
158C---------- Zimmerman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
163B---------- Brainerd	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
169B---------- Braham	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
170----------- Blomford	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
180----------- Gonvick	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
183----------- Dassel	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
200B---------- Holdingford	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
200C---------- Holdingford	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
202----------- Meehan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
204B---------- Cushing	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
204C---------- Cushing	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
204E---------- Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
207B---------- Nymore	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
207C---------- Nymore	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
260 Duelm	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: droughty.
261 Isan	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
292 Alstad	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
325 Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
341A Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
341B Arvilla	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
341C Arvilla	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
374B Rockwood	Moderate: dense layer.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
374C Rockwood	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
374D Rockwood	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
375 Forada	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness, droughty.
402C Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
402E Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
406B Dorset	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
406C Dorset	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
413 Osakis	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Moderate: droughty.
421B Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
421C Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
446 Normania	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
453B DeMontreville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
453C DeMontreville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
454B Mahtomedi	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: small stones.
454C Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones.
454E Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
458B Menahga	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
458C Menahga	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, droughty.
458E Menahga	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
514 Tacoosh	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
540 Seelyeville	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, excess humus.
541 Rifle	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
543 Markey	Severe: cutbanks cave, excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
544 Cathro	Severe: excess humus, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
545 Rondeau	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, excess humus.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
565 Eckvoll	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
571 Coriff	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
572 Lowlein	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Slight.
582 Roliss	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
701 Runeberg	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
703 Paddock	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: large stones, wetness.
720B Blowers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: large stones.
800B*:						
Kandota	Moderate: dense layer.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
Dorset	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
800C*:						
Kandota	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
Dorset	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
800E*:						
Kandota	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Dorset	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
808*:						
Wykeham	Moderate: dense layer, wetness.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Moderate: large stones.
Runeberg	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
823*:						
Hangaard	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Severe: droughty.
Sioux	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
824C*:						
Dorset	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Sioux	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
824E*:						
Dorset	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
825*:						
Gonvick	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
Flom	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
873*:						
Prebish	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
Nokay	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
928B*:						
Cushing	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
DeMontreville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Mahtomedi	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: small stones.
928C*:						
Cushing	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
DeMontreville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
928C*:						
Mahtomedi--------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones.
928E*:						
Cushing----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
DeMontreville----	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Mahtomedi--------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
967C*:						
Waukon-----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Langhei----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
967D*:						
Waukon-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Langhei----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1015. Psamments						
1029*. Pits						
1054*:						
Prebish----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
Histosols.						
1055*: Aquolls.						
Histosols.						
1926*:						
Bowstring--------	Severe: cutbanks cave, excess humus, wetness.	Severe: flooding, wetness, low strength.	Severe: flooding, wetness, low strength.	Severe: flooding, wetness, low strength.	Severe: wetness, flooding, frost action.	Severe: wetness, flooding, excess humus.
Aquents.						

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1927-------------- Clotho	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
1932-------------- Runeberg	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
1943-------------- Roscommon	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1956-------------- Staples	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
7A, 7B Hubbard	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
36 Flom	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
38B Waukon	Moderate: percs slowly.	Moderate: seepage, slope, excess humus.	Moderate: too clayey.	Slight	Fair: too clayey.
38C Waukon	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
53B Kandota	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: large stones.
53C Kandota	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: large stones, slope.
53D Kandota	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
75 Bluffton	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
82B Redeye	Severe: percs slowly, poor filter.	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
82C Redeye	Severe: percs slowly, poor filter.	Severe: seepage, slope.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
111 Hangaard	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
121 Wykeham	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: large stones, wetness.
127A, 127B Sverdrup	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
139B---------------- Huntersville	Severe: wetness, percs slowly.	Severe: seepage.	Moderate: wetness.	Severe: seepage.	Fair: small stones, wetness.
142----------------- Nokay	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness.	Severe: wetness.	Poor: wetness.
144B---------------- Flak	Severe: percs slowly.	Severe: seepage.	Slight-----------	Slight-----------	Fair: small stones.
144C---------------- Flak	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
158B---------------- Zimmerman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
158C---------------- Zimmerman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
163B---------------- Brainerd	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Moderate: wetness.	Fair: small stones, wetness.
169B---------------- Braham	Moderate: percs slowly.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
170----------------- Blomford	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
180----------------- Gonvick	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
183----------------- Dassel	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
200B---------------- Holdingford	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Fair: small stones.
200C---------------- Holdingford	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
202----------------- Meehan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
204B---------------- Cushing	Severe: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Fair: small stones.
204C---------------- Cushing	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
204E----------------- Cushing	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
207B----------------- Nymore	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
207C----------------- Nymore	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
260----------------- Duelm	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
261----------------- Isan	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
292----------------- Alstad	Severe: wetness, percs slowly.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness.
325----------------- Prebish	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
341A, 341B---------- Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
341C----------------- Arvilla	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
374B----------------- Rockwood	Severe: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
374C----------------- Rockwood	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
374D----------------- Rockwood	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
375----------------- Forada	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
402C----------------- Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
402E Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
406B Dorset	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
406C Dorset	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
413 Osakis	Severe: poor filter, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
421B Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
421C Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
446 Normania	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
453B DeMontreville	Severe: percs slowly.	Severe: seepage.	Slight	Severe: seepage.	Fair: small stones.
453C DeMontreville	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.
454B Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454C Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454E Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
458B Menahga	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
458C Menahga	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
458E---------------- Menahga	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
514----------------- Tacoosh	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
540----------------- Seelyeville	Severe: ponding, subsides.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding, excess humus.
541----------------- Rifle	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
543----------------- Markey	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
544----------------- Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
545----------------- Rondeau	Severe: ponding, subsides.	Severe: seepage, excess humus.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
565----------------- Eckvoll	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
571----------------- Coriff	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
572----------------- Lowlein	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: wetness.
582----------------- Roliss	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
701----------------- Runeberg	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
703----------------- Paddock	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
720B---------------- Blowers	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Moderate: wetness.	Moderate: wetness.	Fair: small stones, wetness.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
800B*:					
Kandota	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: large stones.
Dorset	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
800C*:					
Kandota	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: large stones, slope.
Dorset	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
800E*:					
Kandota	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Dorset	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
808*:					
Wykeham	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: large stones, wetness.
Runeberg	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
823*:					
Hangaard	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
824C*:					
Dorset	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
824E*:					
Dorset	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
825*:					
Gonvick	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Flom	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
873*:					
Prebish	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Nokay	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Poor: wetness.
928B*:					
Cushing	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
DeMontreville	Severe: percs slowly.	Severe: seepage.	Slight	Severe: seepage.	Fair: small stones.
Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
928C*:					
Cushing	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
DeMontreville	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.
Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
928E*:					
Cushing	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
928E*:					
DeMontreville	Severe: percs slowly, slope.	Severe: seepage, slope.	Severe: slope.	Severe: seepage, slope.	Poor: slope.
Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
967C*:					
Waukon	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Langhei	Moderate: percs slowly, slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
967D*:					
Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1015. Psamments					
1029*. Pits					
1054*:					
Prebish	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
Histosols.					
1055*:					
Aquolls.					
Histosols.					
1926*:					
Bowstring	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: wetness, excess humus.
Aquents.					
1927 Clotho	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1932 Runeberg	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1943---------------- Roscommon	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
1956---------------- Staples	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
7A, 7B Hubbard	Good	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
36 Flom	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
38B Waukon	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
38C Waukon	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
53B, 53C Kandota	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones.
53D Kandota	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, slope.
75 Bluffton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
82B, 82C Redeye	Good	Improbable: thin layer.	Improbable: too sandy.	Poor: small stones.
111 Hangaard	Fair: wetness.	Probable	Probable	Poor: small stones.
121 Wykeham	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
127A, 127B Sverdrup	Good	Probable	Improbable: too sandy.	Poor: too sandy.
139B Huntersville	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
142 Nokay	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
144B, 144C Flak	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
158B, 158C Zimmerman	Good	Probable	Improbable: too sandy.	Poor: too sandy.
163B Brainerd	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
169B Braham	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
170 Blomford	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, wetness.
180 Gonvick	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
183 Dassel	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
200B, 200C Holdingford	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
202 Meehan	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
204B, 204C Cushing	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
204E Cushing	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
207B, 207C Nymore	Good	Probable	Improbable: too sandy.	Poor: too sandy.
260 Duelm	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
261 Isan	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
292 Alstad	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
325 Prebish	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
341A, 341B, 341C Arvilla	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
374B Rockwood	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
374C Rockwood	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim, slope.
374D Rockwood	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
375 Forada	Fair: wetness.	Probable	Probable	Poor: small stones.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
402C Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
402E Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
406B, 406C Dorset	Good	Probable	Probable	Poor: small stones, area reclaim.
413 Osakis	Good	Probable	Probable	Poor: small stones, area reclaim.
421B Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
421C Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
446 Normania	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
453B, 453C DeMontreville	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, small stones.
454B, 454C Mahtomedi	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
454E Mahtomedi	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
458B, 458C Menahga	Good	Probable	Improbable: too sandy.	Poor: too sandy.
458E Menahga	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope, too sandy.
514 Tacoosh	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
540 Seelyeville	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
541 Rifle	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
543 Markey	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
544 Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
545 Rondeau	Poor: wetness.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
565 Eckvoll	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
571 Coriff	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, thin layer.
572 Lowlein	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, thin layer.
582 Roliss	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
701 Runeberg	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
703 Paddock	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
720B Blowers	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
800B*, 800C*:				
Kandota	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones.
Dorset	Good	Probable	Probable	Poor: small stones, area reclaim.
800E*:				
Kandota	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, slope.
Dorset	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
808*:				
Wykeham	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Runeberg	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
823*:				
Hangaard	Fair: wetness.	Probable	Probable	Poor: small stones.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
824C*:				
Dorset	Good	Probable	Probable	Poor: small stones, area reclaim.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
824E*:				
Dorset	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
825*:				
Gonvick	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Flom	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
873*:				
Prebish	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Nokay	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
928B*, 928C*:				
Cushing	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
DeMontreville	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, small stones.
Mahtomedi	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
928E*:				
Cushing	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
928E*:				
DeMontreville	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, small stones, slope.
Mahtomedi	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
967C*:				
Waukon	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Langhei	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
967D*:				
Waukon	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Langhei	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1015. Psamments				
1029*. Pits				
1054*:				
Prebish	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Histosols.				
1055*: Aquolls.				
Histosols.				
1926*:				
Bowstring	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
Aquents.				
1927 Clotho	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
1932 Runeberg	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1943------------------- Roscommon	Poor: wetness.	Probable-------------	Improbable: too sandy.	Poor: wetness.
1956------------------- Staples	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: small stones, wetness, too sandy.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
7A Hubbard	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake.	Too sandy, soil blowing.	Droughty.
7B Hubbard	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
36 Flom	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
38B Waukon	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
38C Waukon	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope	Slope.
53B Kandota	Moderate: seepage, slope.	Slight	Deep to water	Soil blowing, rooting depth, slope.	Soil blowing	Rooting depth.
53C, 53D Kandota	Severe: slope.	Slight	Deep to water	Soil blowing, rooting depth, slope.	Slope, soil blowing.	Slope, rooting depth.
75 Bluffton	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
82B Redeye	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Large stones, droughty.
82C Redeye	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Large stones, slope, droughty.
111 Hangaard	Severe: seepage.	Severe: seepage, wetness.	Cutbanks cave	Wetness, droughty, soil blowing.	Wetness, too sandy, soil blowing.	Wetness, droughty.
121 Wykeham	Moderate: seepage.	Moderate: wetness.	Favorable	Wetness, soil blowing.	Wetness, soil blowing.	Rooting depth.
127A Sverdrup	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
127B Sverdrup	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
139B Huntersville	Severe: seepage.	Severe: seepage, piping.	Frost action	Wetness, droughty.	Wetness, soil blowing, percs slowly.	Droughty, rooting depth.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
142 Nokay	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, soil blowing, percs slowly.	Wetness, rooting depth, soil blowing.	Wetness, rooting depth, percs slowly.
144B Flak	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, droughty, soil blowing.	Soil blowing, percs slowly.	Droughty, rooting depth.
144C Flak	Severe: slope.	Severe: piping.	Deep to water	Slope, droughty, soil blowing.	Slope, soil blowing, percs slowly.	Slope, droughty, rooting depth.
158B Zimmerman	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
158C Zimmerman	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
163B Brainerd	Moderate: seepage.	Severe: piping.	Percs slowly	Wetness, droughty.	Wetness, soil blowing.	Rooting depth, droughty.
169B Braham	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Soil blowing	Droughty.
170 Blomford	Severe: seepage.	Severe: piping, wetness.	Favorable	Wetness, droughty.	Erodes easily, wetness, soil blowing.	Wetness, erodes easily, droughty.
180 Gonvick	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
183 Dassel	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
200B Holdingford	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, soil blowing, rooting depth.	Soil blowing	Rooting depth.
200C Holdingford	Severe: slope.	Severe: piping.	Deep to water	Slope, soil blowing, rooting depth.	Slope, soil blowing.	Slope, rooting depth.
202 Meehan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
204B Cushing	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
204C, 204E Cushing	Severe: slope.	Severe: thin layer.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
207B Nymore	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
207C-------------- Nymore	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
260--------------- Duelm	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
261--------------- Isan	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Ponding, too sandy, soil blowing.	Wetness, droughty.
292--------------- Alstad	Moderate: seepage.	Severe: thin layer.	Frost action---	Wetness, soil blowing.	Wetness--------	Favorable.
325--------------- Prebish	Slight---------	Severe: piping, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
341A-------------- Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
341B-------------- Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
341C-------------- Arvilla	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
374B-------------- Rockwood	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, soil blowing, percs slowly.	Soil blowing---	Rooting depth.
374C, 374D-------- Rockwood	Severe: slope.	Severe: piping.	Deep to water	Slope, soil blowing, percs slowly.	Slope, soil blowing.	Slope, rooting depth.
375--------------- Forada	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness, droughty, soil blowing.	Wetness, too sandy, soil blowing.	Wetness, droughty.
402C-------------- Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, rooting depth.
402E-------------- Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.
406B-------------- Dorset	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
406C-------------- Dorset	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
413--------------- Osakis	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
421B: Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
421C: Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
446: Normania	Moderate: seepage.	Moderate: piping, wetness.	Frost action	Wetness	Wetness	Favorable.
453B: DeMontreville	Severe: seepage.	Moderate: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Soil blowing	Droughty, rooting depth.
453C: DeMontreville	Severe: seepage, slope.	Moderate: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, soil blowing.	Slope, droughty, rooting depth.
454B: Mahtomedi	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
454C, 454E: Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.
458B: Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
458C, 458E: Menahga	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
514: Tacoosh	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
540: Seelyeville	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides.	Ponding, soil blowing.	Ponding	Wetness.
541: Rifle	Severe: seepage.	Severe: excess humus, ponding.	Ponding, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
543: Markey	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
544: Cathro	Severe: seepage.	Severe: piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
545: Rondeau	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides.	Ponding, soil blowing, percs slowly.	Ponding, soil blowing.	Wetness.
565: Eckvoll	Severe: seepage.	Moderate: piping, wetness.	Frost action	Wetness, fast intake, soil blowing.	Wetness, soil blowing.	Favorable.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
571 Coriff	Severe: seepage.	Severe: piping, wetness.	Frost action	Wetness, soil blowing.	Erodes easily, wetness, soil blowing.	Wetness, erodes easily.
572 Lowlein	Severe: seepage.	Severe: piping.	Favorable	Soil blowing, wetness.	Erodes easily, soil blowing, wetness.	Erodes easily.
582 Roliss	Moderate: seepage.	Severe: wetness, piping.	Frost action	Wetness	Wetness	Wetness.
701 Runeberg	Slight	Severe: piping, ponding.	Ponding, percs slowly, frost action.	Ponding, soil blowing, percs slowly.	Ponding, soil blowing, percs slowly.	Wetness, rooting depth, percs slowly.
703 Paddock	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness, soil blowing, percs slowly.	Wetness, rooting depth, soil blowing.	Wetness, rooting depth.
720B Blowers	Moderate: seepage, slope.	Severe: piping.	Frost action, slope.	Slope, wetness, soil blowing.	Wetness, soil blowing, percs slowly.	Rooting depth.
800B*:						
Kandota	Moderate: seepage, slope.	Slight	Deep to water	Soil blowing, rooting depth, slope.	Soil blowing	Rooting depth.
Dorset	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
800C*, 800E*:						
Kandota	Severe: slope.	Slight	Deep to water	Soil blowing, rooting depth, slope.	Slope, soil blowing.	Slope, rooting depth.
Dorset	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
808*:						
Wykeham	Moderate: seepage.	Moderate: wetness.	Favorable	Wetness, soil blowing.	Wetness, soil blowing.	Rooting depth.
Runeberg	Slight	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, soil blowing, percs slowly.	Wetness, soil blowing, percs slowly.	Wetness, rooting depth, percs slowly.
823*:						
Hangaard	Severe: seepage.	Severe: seepage, wetness.	Cutbanks cave	Wetness, droughty, soil blowing.	Wetness, too sandy, soil blowing.	Wetness, droughty.
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, rooting depth.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
824C*:						
Dorset	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
824E*:						
Dorset	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.
825*:						
Gonvick	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
Flom	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
873*:						
Prebish	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness, soil blowing.	Wetness, soil blowing.	Wetness.
Nokay	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, soil blowing, percs slowly.	Wetness, rooting depth, soil blowing.	Wetness, rooting depth, percs slowly.
928B*:						
Cushing	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
DeMontreville	Severe: seepage.	Moderate: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Soil blowing	Droughty, rooting depth.
Mahtomedi	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
928C*, 928E*:						
Cushing	Severe: slope.	Severe: thin layer.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
DeMontreville	Severe: seepage, slope.	Moderate: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, soil blowing.	Slope, droughty, rooting depth.
Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
967C*, 967D*:						
Waukon----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope----------	Slope.
Langhei----------	Severe: slope.	Moderate: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
1015. Psamments						
1029*. Pits						
1054*:						
Prebish----------	Slight---------	Severe: piping, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
Histosols.						
1055*:						
Aquolls.						
Histosols.						
1926*:						
Bowstring--------	Severe: seepage.	Severe: excess humus, wetness.	Flooding, subsides, frost action.	Wetness, flooding.	Wetness--------	Wetness.
Aquents.						
1927-------------- Clotho	Slight---------	Severe: piping, wetness.	Frost action---	Wetness, rooting depth.	Wetness--------	Wetness, rooting depth.
1932-------------- Runeberg	Slight---------	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, soil blowing, percs slowly.	Wetness, soil blowing, percs slowly.	Wetness, rooting depth, percs slowly.
1943-------------- Roscommon	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Ponding, too sandy, soil blowing.	Wetness, droughty.
1956-------------- Staples	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness, droughty, fast intake.	Large stones, wetness, too sandy.	Large stones, wetness, droughty.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
7A, 7B----------- Hubbard	0-15	Loamy sand-------	SM, SP-SM	A-2	0	98-100	95-100	50-80	10-25	<20	NP
	15-30	Sand, coarse sand, loamy sand.	SP-SM, SW-SM	A-1, A-3, A-2-4	0	98-100	85-100	25-75	5-12	<20	NP
	30-60	Sand, coarse sand	SP, SW	A-1, A-3, A-2	0	95-100	85-100	20-70	2-5	<20	NP
36--------------- Flom	0-14	Loam-------------	CL-ML, CL	A-4, A-6, A-7	0	95-100	95-100	80-100	60-90	20-50	5-20
	14-24	Clay loam, loam	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-50	10-30
	24-60	Loam, clay loam	CL	A-6, A-7	0	95-100	90-98	80-95	60-90	20-50	10-30
38B, 38C--------- Waukon	0-10	Loam-------------	OL, ML, CL, CL-ML	A-6, A-7, A-4	0-3	95-100	90-98	80-95	60-90	20-50	3-30
	10-31	Clay loam, loam, sandy clay loam.	CL	A-6, A-7	0-3	95-100	90-98	75-95	50-85	20-50	10-30
	31-60	Sandy loam, loam, clay loam.	ML, CL, CL-ML	A-4, A-6	0-3	95-100	90-98	70-95	50-80	15-40	5-20
53B, 53C, 53D---- Kandota	0-6	Sandy loam-------	SM, SM-SC	A-4	5-15	90-100	85-100	65-80	40-50	25-30	2-5
	6-26	Sandy loam, fine sandy loam.	SM, SM-SC	A-4	5-15	88-100	85-90	65-80	35-50	<20	1-5
	26-33	Sandy clay loam, sandy loam.	SC	A-6	5-15	90-100	85-95	70-80	35-50	25-35	10-20
	33-60	Sandy loam, fine sandy loam.	SM-SC, SC	A-4	5-15	85-95	85-95	65-80	35-50	<25	5-10
75--------------- Bluffton	0-20	Loam-------------	CL	A-6, A-7	0	98-100	85-100	85-95	50-80	30-45	10-20
	20-44	Clay loam, loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0-3	95-100	85-100	70-90	40-60	20-35	3-18
	44-60	Loam, sandy loam	CL, ML, SC, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-65	20-40	3-20
82B, 82C--------- Redeye	0-3	Loamy sand-------	SM, SP-SM	A-2-4	0	90-100	80-95	65-80	10-30	<20	NP-4
	3-22	Loamy sand, sand, fine sand.	SM, SP-SM	A-2-4, A-3, A-1-b	0-23	75-95	40-90	30-65	5-15	<20	NP-4
	22-35	Sandy loam-------	SM, SC, SM-SC	A-2-4, A-2-6, A-1-b	0-10	85-100	70-95	45-70	15-35	<25	NP-12
	35-60	Sandy loam-------	SM, SC, SM-SC	A-2-4, A-1-b	0-10	85-100	70-95	45-70	15-35	<25	NP-9
111-------------- Hangaard	0-14	Sandy loam-------	SM	A-2, A-4	0-3	95-100	80-100	50-75	20-45	---	NP
	14-18	Loamy sand, loamy coarse sand.	SP-SM, SM	A-3, A-1, A-2	2-5	80-100	60-95	35-70	5-25	---	NP
	18-60	Gravelly coarse sand, sand, coarse sand.	SP-SM, SP	A-3, A-1, A-2	2-5	70-95	55-90	30-60	0-10	---	NP
121-------------- Wykeham	0-7	Fine sandy loam	SM, SM-SC	A-4	2-8	90-100	85-100	65-80	40-50	25-30	2-5
	7-19	Gravelly sandy loam, fine sandy loam, sandy loam.	SM, SM-SC	A-4, A-2	2-8	85-100	70-95	65-80	25-50	<20	1-5
	19-28	Sandy clay loam, sandy loam.	SC, CL	A-6	5-15	90-100	85-95	70-80	35-60	30-35	10-15
	28-60	Sandy loam, fine sandy loam.	SM-SC, SC	A-4	5-15	85-95	85-95	65-80	35-50	20-25	5-10

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
127A, 127B-------	0-14	Sandy loam-------	SM	A-4	0	100	95-100	60-70	35-50	---	NP
Sverdrup	14-28	Loam, sandy loam, loamy sand.	ML, SM	A-2, A-4	0	100	95-100	50-75	30-70	<30	NP-5
	28-60	Sand, fine sand	SP, SP-SM	A-3, A-2	0	100	95-100	50-90	2-10	---	NP
139B-------------	0-6	Loamy sand-------	SM, SP-SM	A-2-4	0	90-100	80-95	65-80	10-30	<20	NP-3
Huntersville	6-27	Loamy sand, loamy fine sand, sand.	SM, SP-SM	A-2-4, A-1-b, A-3	0-23	75-95	40-90	30-65	5-15	<20	NP-3
	27-53	Sandy loam-------	SM, SM-SC, SC	A-2-4, A-1-b	0-10	85-100	70-95	45-50	20-35	<25	NP-9
	53-60	Sandy loam-------	SM, SM-SC, SC	A-2-4, A-1-b	0-10	85-100	70-95	45-60	15-35	<25	NP-9
142--------------	0-5	Sandy loam-------	SM	A-2, A-4	0-2	90-100	80-100	55-85	25-50	<25	NP-4
Nokay	5-18	Sandy loam, fine sandy loam, loam.	SM, ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	<25	NP-4
	18-28	Sandy loam, fine sandy loam, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	20-30	2-7
	28-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4
144B, 144C-------	0-8	Sandy loam-------	SM	A-2, A-4	0-2	90-100	80-100	60-80	25-45	<22	NP-4
Flak	8-14	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-75	25-40	<22	NP-4
	14-33	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
	33-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
158B, 158C-------	0-4	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	<20	NP
Zimmerman	4-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	5-20	<20	NP
163B-------------	0-8	Sandy loam-------	SM	A-2, A-4	0-2	90-100	80-100	60-85	25-45	<22	NP-4
Brainerd	8-18	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0-4	85-95	75-93	50-75	25-40	<22	NP-7
	18-36	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0-4	85-95	75-95	50-70	25-40	<22	NP-7
	36-42	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-2	85-95	75-95	50-70	25-40	<22	NP-4
	42-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-2	85-95	75-95	50-70	25-40	<22	NP-4
169B-------------	0-9	Loamy sand-------	SM	A-2	0	100	100	55-70	20-35	---	NP
Braham	9-24	Loamy fine sand, loamy sand, sand.	SP-SM, SM	A-2	0	100	100	65-90	10-20	---	NP
	24-40	Silty clay loam, loam, silt loam.	CL, ML, CL-ML	A-4, A-6	0-5	95-100	85-100	75-90	50-85	20-40	3-15
	40-60	Silt loam, loam, silty clay loam.	CL, ML, CL-ML	A-4, A-6	0-5	95-100	85-100	75-90	50-85	20-40	3-15

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
170-------------- Blomford	0-9	Loamy sand-------	SM	A-2	0	100	100	70-80	20-35	<20	NP
	9-31	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	65-80	5-20	<20	NP
	31-48	Sandy clay loam, clay loam, silt loam.	ML, CL, CL-ML	A-6, A-4, A-7	0-8	95-100	85-100	80-95	50-85	30-45	6-20
	48-60	Loam, sandy clay loam, silt loam.	ML, CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-100	50-90	25-40	3-15
180-------------- Gonvick	0-12	Loam-------------	ML, CL, CL-ML	A-4, A-6	0-3	95-100	90-98	85-95	50-75	20-40	3-20
	12-32	Loam, clay loam	CL	A-6, A-7	0-3	95-100	90-98	75-95	50-85	20-50	10-30
	32-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-3	95-100	90-98	70-95	50-80	15-40	5-20
183-------------- Dassel	0-9	Mucky sandy loam	SM, OL	A-4	0	100	95-100	70-85	40-50	<30	NP-4
	9-31	Stratified loamy fine sand to fine sandy loam.	SM	A-4, A-2	0	100	95-100	60-75	30-40	<30	NP-4
	31-60	Stratified loamy sand to coarse sand.	SM, SP-SM	A-2	0	100	80-100	50-80	10-35	---	NP
200B, 200C------- Holdingford	0-6	Sandy loam-------	SM	A-2	0-2	95-100	85-100	60-70	25-35	<20	NP-4
	6-13	Sandy loam, fine sandy loam.	SM	A-2	0-2	95-100	85-100	60-70	25-35	<20	NP-4
	13-47	Fine sandy loam, sandy loam, loam.	SM, SC, ML, CL	A-4	5-10	90-100	75-95	60-90	35-70	15-30	2-10
	47-60	Sandy loam, fine sandy loam, loam.	SM, ML, CL-ML, SM-SC	A-4	3-7	90-100	75-95	60-90	35-70	<20	NP-5
202-------------- Meehan	0-8	Loamy sand-------	SM	A-2, A-1	0	90-100	75-100	40-90	15-30	---	NP
	8-35	Sand, loamy sand, coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	90-100	75-100	40-90	3-30	---	NP
	35-60	Sand, coarse sand	SP, SP-SM	A-1, A-3, A-2	0	90-100	75-100	40-90	0-5	---	NP
204B, 204C, 204E- Cushing	0-3	Sandy loam-------	SM, SM-SC, ML, CL-ML	A-4, A-2, A-1	0-7	75-100	75-100	45-95	20-65	<25	2-7
	3-17	Loam, silt loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-7	75-100	75-100	35-100	12-90	<23	NP-6
	17-54	Loam, sandy clay loam, sandy loam.	SC, CL	A-2, A-4, A-6, A-7	0-7	75-100	75-100	45-95	20-75	25-45	9-27
	54-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-2, A-4, A-6, A-1	0-7	75-100	75-100	45-95	20-75	<34	2-20
207B, 207C------- Nymore	0-9	Loamy sand-------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-75	5-30	<20	NP
	9-60	Sand, coarse sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	95-100	85-100	45-75	2-15	<20	NP
260-------------- Duelm	0-15	Loamy sand-------	SM, SP-SM	A-2, A-1	0	90-100	85-100	35-80	10-25	<20	NP
	15-44	Loamy sand, loamy coarse sand, coarse sand.	SM, SP-SM	A-2, A-3, A-1	0	90-100	80-100	35-80	5-25	<20	NP
	44-60	Coarse sand, sand	SP, SM, SP-SM	A-2, A-3, A-1	0	90-100	80-100	35-85	3-15	<20	NP

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
261 Isan	0-19	Loamy sand	SM	A-2	0	95-100	92-100	50-75	12-30	<20	NP
	19-27	Sand, loamy sand	SM, SP-SM	A-2	0	95-100	92-100	50-75	10-30	<20	NP
	27-60	Sand, coarse sand	SM, SP	A-1, A-2, A-3	0	85-100	80-100	35-70	2-15	<20	NP
292 Alstad	0-9	Sandy loam	ML, SM, CL-ML, SM-SC	A-4, A-2	0	95-100	95-100	55-85	25-55	<25	2-7
	9-14	Silt loam, fine sandy loam, sandy loam.	ML, CL, SM, SC	A-2, A-4	0	95-100	95-100	55-100	25-100	<26	2-8
	14-34	Loam, sandy loam, sandy clay loam.	CL, SC	A-4, A-6, A-7	0	80-100	75-100	65-100	45-95	25-45	9-27
	34-48	Sandy clay loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4, A-2, A-7	0	80-100	75-100	60-100	25-80	20-45	9-28
	48-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-6, A-4, A-2, A-1	0-3	80-100	75-100	45-95	20-75	<35	2-20
325 Prebish	0-12	Fine sandy loam	SM	A-4	0-2	90-100	90-100	55-80	35-50	<20	NP-4
	12-45	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	80-95	77-90	45-80	25-50	<20	NP-4
	45-60	Sandy loam, fine sandy loam.	SM	A-2	0-10	80-95	77-85	55-70	20-35	<20	NP-4
341A, 341B, 341C Arvilla	0-11	Sandy loam	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	11-21	Sandy loam, loam, coarse sandy loam.	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	21-60	Gravelly coarse sand, loamy sand, gravelly sand.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-10	---	NP
374B, 374C, 374D Rockwood	0-8	Sandy loam	SM	A-2, A-4	5-10	85-100	85-100	60-80	30-40	<25	NP-4
	8-16	Sandy loam	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-90	60-75	30-40	<20	1-8
	16-37	Sandy loam	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	30-40	<25	2-10
	37-46	Sandy loam	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	30-40	<25	2-10
	46-60	Sandy loam	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-90	60-75	25-40	<25	2-10
375 Forada	0-18	Sandy loam	SM, SM-SC	A-4, A-2	0	90-100	85-100	60-90	30-50	15-25	NP-5
	18-33	Sandy loam, loam, loamy sand.	ML, SM	A-4, A-2	0	95-100	85-100	55-85	30-60	20-40	NP-10
	33-60	Sand, coarse sand, gravelly coarse sand.	SP, SM, SP-SM, GP-GM	A-1, A-2, A-3	0	50-90	50-80	40-70	2-30	---	NP

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
402C, 402E------- Sioux	0-8	Loamy sand-------	SM, SM-SC	A-2	0-5	95-100	90-100	50-75	15-30	<25	NP-5
	8-60	Gravelly loamy sand, very gravelly loamy sand, very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
406B, 406C------- Dorset	0-8	Sandy loam-------	SM, SM-SC	A-4, A-2	0	90-100	85-100	50-70	25-50	<25	NP-5
	8-14	Loam, sandy loam	SM-SC, SC, CL-ML, CL	A-4, A-6	0	90-100	85-100	50-90	35-75	15-30	4-14
	14-34	Gravelly coarse sand, gravelly loamy coarse sand, gravelly sand.	SP-SM, SM, SM-SC, GM	A-1, A-2	0-5	50-90	35-80	20-50	10-25	<20	NP-7
	34-60	Gravelly coarse sand, gravelly sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	40-90	35-80	15-40	0-10	<20	NP
413-------------- Osakis	0-13	Sandy loam-------	SM, SM-SC	A-4, A-2	0	95-100	85-100	50-70	25-40	<25	NP-7
	13-17	Loam, sandy loam	SM, ML, CL-ML, SM-SC	A-4, A-2	0	95-100	85-100	55-90	25-70	20-35	1-8
	17-60	Gravelly loamy sand, gravelly coarse sand, very gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	30-95	20-85	10-50	0-10	<20	NP
421B, 421C------- Ves	0-14	Loam-------------	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	14-26	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	26-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
446-------------- Normania	0-12	Loam-------------	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
	12-29	Loam, clay loam	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-85	25-40	8-20
	29-60	Loam, clay loam	CL	A-6, A-4	0-5	90-100	85-100	80-90	55-80	30-40	8-15
453B, 453C------- DeMontreville	0-3	Loamy sand-------	SM	A-2	0-5	90-100	85-100	65-80	20-35	<20	NP
	3-23	Loamy sand, sand, fine sand.	SP, SP-SM, SM	A-2, A-3	0-5	90-100	85-100	60-80	2-35	<20	NP
	23-48	Sandy loam, sandy clay loam, loam.	SC, SM, CL, ML	A-2, A-4	0-5	80-100	70-90	55-70	20-55	15-25	3-10
	48-60	Sandy loam, coarse sandy loam.	SC, SM, SM-SC	A-2, A-4	0-5	80-100	70-90	45-65	25-45	15-25	3-8
454B------------- Mahtomedi	0-11	Loamy sand-------	SM, SM-SC	A-2, A-1	0-2	95-100	60-90	40-86	15-30	<20	NP-4
	11-30	Sand, coarse sand, gravelly coarse sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-75	5-15	<20	NP
	30-60	Sand, coarse sand, gravelly coarse sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-15	55-95	50-90	30-70	2-15	<20	NP
454C, 454E------- Mahtomedi	0-2	Loamy sand-------	SM, SM-SC	A-2, A-1	0-2	95-100	60-90	40-86	15-30	<20	NP-4
	2-25	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-75	5-15	<20	NP
	25-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-15	55-95	50-90	30-70	2-15	<20	NP

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
458B, 458C, 458E- Menahga	0-3	Loamy sand-------	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	3-29	Coarse sand, sand, loamy coarse sand.	SP, SP-SM	A-3, A-2, A-1	0	100	80-100	30-75	0-10	---	NP
	29-60	Coarse sand, sand	SP, SP-SM	A-3, A-2, A-1	0	100	80-100	30-75	0-10	---	NP
514-------------- Tacoosh	0-9	Sapric material	PT	A-8	---	---	---	---	---	---	---
	9-30	Hemic material---	PT	A-8	---	---	---	---	---	---	---
	30-60	Sandy loam, loam, clay loam.	SM, ML, CL-ML, CL	A-2, A-4, A-6	0-10	85-100	85-95	65-95	25-75	15-35	NP-20
540-------------- Seelyeville	0-10	Sapric material	PT	A-8	0	---	---	---	---	---	---
	10-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
541-------------- Rifle	0-9	Sapric material	PT	A-8	0	---	---	---	---	---	---
	9-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
543-------------- Markey	0-38	Sapric material	PT	A-8	---	---	---	---	---	---	---
	38-60	Sand, loamy sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3	0	100	85-100	60-75	0-20	---	NP
544-------------- Cathro	0-12	Sapric material	PT	A-8	0	---	---	---	---	---	---
	12-30	Sapric material	PT	A-8	0	---	---	---	---	---	---
	30-60	Sandy loam, loam, silt loam.	SM, ML, SC, CL	A-4	0-5	80-100	65-100	60-100	35-90	<25	3-10
545-------------- Rondeau	0-30	Sapric material	PT	A-8	0	---	---	---	---	---	NP
	30-60	Coprogenous earth.	OL	A-5	0	100	95-100	80-90	60-80	40-50	5-10
565-------------- Eckvoll	0-9	Loamy sand-------	SM, SM-SC	A-4, A-2	0-2	90-100	85-100	45-80	25-40	<20	NP-7
	9-27	Fine sand, sand, loamy sand.	SM, SP-SM	A-1, A-2, A-3	0-2	90-100	85-100	45-75	5-30	<20	NP-4
	27-39	Clay loam, silty clay loam, loam.	SC, CL	A-4, A-6, A-7	0-5	90-100	85-100	65-95	45-75	25-50	7-25
	39-60	Loam, clay loam, silt loam.	CL	A-4, A-6, A-7	0-5	90-100	85-100	70-95	55-80	25-45	7-20
571-------------- Coriff	0-19	Sandy loam-------	SM-SC, SM	A-4	0	90-100	85-100	60-75	35-50	<20	NP-5
	19-35	Sandy loam, fine sandy loam, loamy sand.	SM-SC, SM	A-4, A-2, A-3	0	90-100	85-100	60-80	35-50	<20	NP-5
	35-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	90-100	80-90	50-80	25-40	5-15
572-------------- Lowlein	0-15	Sandy loam-------	SM, SM-SC	A-4	0	90-100	85-100	60-75	35-50	<20	NP-5
	15-20	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	90-100	85-100	50-75	5-35	---	NP
	20-31	Sandy loam, fine sandy loam.	SM, SM-SC	A-4	0	90-100	85-100	60-80	35-50	<20	NP-5
	31-60	Loam, silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0-5	90-100	85-100	80-90	55-80	25-40	5-15
582-------------- Roliss	0-16	Loam-------------	CL, CL-ML	A-4, A-6, A-7	0	95-100	80-100	80-100	60-90	20-50	5-30
	16-24	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	80-100	80-90	60-80	20-50	10-30
	24-60	Loam, clay loam	CL, CL-ML	A-6, A-7, A-4	0	95-100	80-100	80-95	60-80	20-50	5-30

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
701--------------- Runeberg	0-10	Sandy loam-------	SM-SC, SM, SC	A-2, A-4, A-6	5-10	85-100	80-95	65-80	25-45	20-30	5-15
	10-26	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	5-10	85-95	80-95	60-75	30-45	15-25	3-10
	26-60	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-95	60-75	30-45	15-25	3-8
703--------------- Paddock	0-9	Sandy loam-------	SM, SM-SC	A-2, A-4	5-10	85-100	80-100	60-80	25-40	<25	1-7
	9-22	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	5-10	85-95	85-90	60-75	25-40	<20	1-5
	22-43	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	25-45	<25	2-10
	43-60	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-90	80-90	60-75	25-40	<20	2-8
720B-------------- Blowers	0-6	Sandy loam-------	SM, SM-SC	A-2, A-4	5-10	85-100	85-100	60-80	30-40	20-30	1-7
	6-17	Sandy loam-------	SM, SM-SC	A-2, A-4	5-10	85-95	85-90	60-75	30-40	<20	1-5
	17-27	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	30-40	<25	2-10
	27-40	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	30-40	<25	2-10
	40-60	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-90	60-75	25-40	<25	2-10
800B*:											
Kandota----------	0-6	Sandy loam-------	SM, SM-SC	A-4	5-15	90-100	85-100	65-80	40-50	25-30	2-5
	6-26	Sandy loam, fine sandy loam.	SM, SM-SC	A-4	5-15	88-100	85-90	65-80	35-50	<20	1-5
	26-33	Sandy clay loam, sandy loam.	SC	A-6	5-15	90-100	85-95	70-80	35-50	25-35	10-20
	33-60	Sandy loam, fine sandy loam.	SM-SC, SC	A-4	5-15	85-95	85-95	65-80	35-50	<25	5-10
Dorset-----------	0-8	Sandy loam-------	SM, SM-SC	A-4, A-2	0	90-100	85-100	50-70	25-50	<25	NP-5
	8-15	Loam, sandy loam	SM-SC, SC, CL-ML, CL	A-4, A-6	0	90-100	85-100	50-90	35-75	15-30	4-14
	15-34	Gravelly sand, gravelly loamy coarse sand, sand.	SP-SM, SM, SM-SC, GM	A-1, A-2	0-5	50-90	35-80	20-50	10-25	<20	NP-7
	34-60	Gravelly coarse sand, sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	40-90	35-80	15-40	0-10	<20	NP
800C*, 800E*:											
Kandota----------	0-6	Sandy loam-------	SM, SM-SC	A-4	5-15	90-100	85-100	65-80	40-50	25-30	2-5
	6-26	Sandy loam, fine sandy loam.	SM, SM-SC	A-4	5-15	88-100	85-90	65-80	35-50	<20	1-5
	26-33	Sandy clay loam, sandy loam.	SC	A-6	5-15	90-100	85-95	70-80	35-50	25-35	10-20
	33-60	Sandy loam, fine sandy loam.	SM-SC, SC	A-4	5-15	85-95	85-95	65-80	35-50	<25	5-10

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
800C*, 800E*:											
Dorset----------	0-8	Sandy loam-------	SM, SM-SC	A-4, A-2	0	90-100	85-100	50-70	25-50	<25	NP-5
	8-15	Loam, sandy loam	SM-SC, SC, CL-ML, CL	A-4, A-6	0	90-100	85-100	50-90	35-75	15-30	4-14
	15-34	Gravelly loamy sand, gravelly loamy coarse sand, gravelly sand.	SP-SM, SM, SM-SC, GM	A-1, A-2	0-5	50-90	35-80	20-50	10-25	<20	NP-7
	34-60	Gravelly coarse sand, gravelly sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	40-90	35-80	15-40	0-10	<20	NP
808*:											
Wykeham---------	0-8	Sandy loam-------	SM, SM-SC	A-4	2-8	90-100	85-100	65-80	40-50	25-30	2-5
	8-14	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC	A-4, A-2	2-8	85-100	70-95	65-80	25-50	<20	1-5
	14-40	Sandy clay loam, sandy loam, loam.	SC, CL	A-6	5-15	90-100	85-95	70-80	35-60	30-35	10-15
	40-60	Sandy loam, fine sandy loam.	SM-SC, SC	A-4	5-15	85-95	85-95	65-80	35-50	20-25	5-10
Runeberg--------	0-12	Sandy loam-------	SM-SC, SM, SC	A-2, A-4, A-6	5-10	85-100	80-95	65-80	25-45	20-30	5-15
	12-26	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	5-10	85-95	80-95	60-75	30-45	15-25	3-10
	26-60	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-95	60-75	30-45	15-25	3-8
823*:											
Hangaard--------	0-9	Sandy loam-------	SM	A-2, A-4	0-3	95-100	80-100	50-75	20-45	---	NP
	9-14	Loamy sand, coarse sandy loam, loamy coarse sand.	SP-SM, SM	A-3, A-1, A-2	2-5	80-100	60-95	35-70	5-25	---	NP
	14-60	Gravelly coarse sand, gravelly sand, coarse sand.	SP-SM, SP	A-3, A-1, A-2	2-5	70-95	55-90	30-60	0-10	---	NP
Sioux-----------	0-7	Loamy sand-------	SM, SM-SC	A-2	0-5	95-100	90-100	50-75	15-30	<25	NP-5
	7-60	Sand, very gravelly loamy sand, gravelly sand.	SP	A-1, A-2, A-3	0	70-95	55-90	30-60	0-10	<25	NP-5
824C*:											
Dorset----------	0-8	Sandy loam-------	SM, SM-SC	A-4, A-2	0	90-100	85-100	50-70	25-50	<25	NP-5
	8-11	Loam, sandy loam	SM-SC, SC, CL-ML, CL	A-4, A-6	0	90-100	85-100	50-90	35-75	15-30	4-14
	11-33	Gravelly loamy sand, gravelly loamy coarse sand, gravelly sand.	SP-SM, SM, SM-SC, GM	A-1, A-2	0-5	50-90	35-80	20-50	10-25	<20	NP-7
	33-60	Gravelly coarse sand, gravelly sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	40-90	35-80	15-40	0-10	<20	NP

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
824C*:											
Sioux-----------	0-6	Sandy loam-------	SM	A-4	0-5	95-100	85-100	60-85	35-45	20-30	NP-7
	6-60	Gravelly sand, gravelly loamy sand, gravelly coarse sand.	SP	A-1, A-2, A-3	0	70-95	55-90	30-60	0-10	<25	NP-5
824E*:											
Dorset----------	0-8	Sandy loam-------	SM, SM-SC	A-4, A-2	0	90-100	85-100	50-70	25-50	<25	NP-5
	8-11	Loam, sandy loam	SM-SC, SC, CL-ML, CL	A-4, A-6	0	90-100	85-100	50-90	35-75	15-30	4-14
	11-33	Gravelly loamy sand, gravelly loamy coarse sand, gravelly sand.	SP-SM, SM, SM-SC, GM	A-1, A-2	0-5	50-90	35-80	20-50	10-25	<20	NP-7
	33-60	Gravelly coarse sand, gravelly sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	40-90	35-80	15-40	0-10	<20	NP
Sioux-----------	0-5	Loamy sand-------	SM, SM-SC	A-2	0-5	95-100	90-100	50-75	15-30	<25	NP-5
	5-60	Gravelly sand, gravelly loamy sand, gravelly coarse sand.	SP	A-1, A-2, A-3	0	70-95	55-90	30-60	0-10	<25	NP-5
825*:											
Gonvick---------	0-13	Loam-------------	ML, CL, CL-ML	A-4, A-6	0-3	95-100	90-98	85-95	50-75	20-40	3-20
	13-25	Loam, clay loam	CL	A-6, A-7	0-3	95-100	90-98	75-95	50-85	20-50	10-30
	25-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-3	95-100	90-98	70-95	50-80	15-40	5-20
Flom------------	0-15	Loam-------------	CL-ML, CL	A-4, A-6, A-7	0	95-100	95-100	80-100	60-90	20-50	5-20
	15-30	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-50	10-30
	30-60	Loam, clay loam	CL	A-6, A-7	0	95-100	90-98	80-95	60-90	20-50	10-30
873*:											
Prebish---------	0-20	Sandy loam-------	SM	A-4	0-2	90-100	90-100	55-80	35-50	<20	NP-4
	20-30	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	80-95	77-90	45-80	25-50	<20	NP-4
	30-60	Sandy loam, fine sandy loam.	SM	A-2	0-10	80-95	77-85	55-70	20-35	<20	NP-4
Nokay-----------	0-7	Sandy loam-------	SM	A-2, A-4	0-2	90-100	80-100	55-85	25-50	<25	NP-4
	7-17	Sandy loam, fine sandy loam, loam.	SM, ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	<25	NP-4
	17-30	Sandy loam, fine sandy loam, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	20-30	2-7
	30-40	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4
	40-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
928B*, 928C*, 928E*:											
Cushing--------	0-3	Sandy loam-------	SM, SM-SC, ML, CL-ML	A-4, A-2, A-1	0-7	75-100	75-100	45-95	20-65	<25	2-7
	3-17	Loam, silt loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-7	75-100	75-100	35-100	12-90	<23	NP-6
	17-54	Loam, sandy clay loam, sandy loam.	SC, CL	A-2, A-4, A-6, A-7	0-7	75-100	75-100	45-95	20-75	25-45	9-27
	54-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-2, A-4, A-6, A-1	0-7	75-100	75-100	45-95	20-75	<34	2-20
DeMontreville--	0-3	Loamy sand-------	SM	A-2	0-5	90-100	85-100	65-80	20-35	<20	NP
	3-23	Loamy sand, sand, fine sand.	SP, SP-SM, SM	A-2, A-3	0-5	90-100	85-100	60-80	2-35	<20	NP
	23-48	Sandy loam, sandy clay loam, loam.	SC, SM, CL, ML	A-2, A-4	0-5	80-100	70-90	55-70	20-55	15-25	3-10
	48-60	Sandy loam, coarse sandy loam.	SC, SM, SM-SC	A-2, A-4	0-5	80-100	70-90	45-65	25-45	15-25	3-8
Mahtomedi------	0-5	Loamy sand-------	SM, SM-SC	A-2, A-1	0-2	95-100	60-90	40-86	15-30	<20	NP-4
	5-30	Sand, coarse sand, gravelly coarse sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-75	5-15	<20	NP
	30-60	Sand, coarse sand, gravelly coarse sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-15	55-95	50-90	30-70	2-15	<20	NP
967C*, 967D*:											
Waukon----------	0-8	Loam-------------	OL, ML, CL, CL-ML	A-6, A-7, A-4	0-3	95-100	90-98	80-95	60-90	20-50	3-30
	8-26	Clay loam, loam, sandy clay loam.	CL	A-6, A-7	0-3	95-100	90-98	75-95	50-85	20-50	10-30
	26-60	Sandy loam, loam, clay loam.	ML, CL, CL-ML	A-4, A-6	0-3	95-100	90-98	70-95	50-80	15-40	5-20
Langhei---------	0-10	Loam-------------	CL-ML, CL	A-4, A-6	0-3	95-100	90-100	75-90	55-80	20-40	5-20
	10-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-3	95-100	90-100	75-90	60-80	20-40	5-25
1015. Psamments											
1029*. Pits											
1054*:											
Prebish---------	0-18	Sandy loam-------	SM	A-4	0-2	90-100	90-100	55-80	35-50	<20	NP-4
	18-46	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	80-95	77-90	45-80	25-50	<20	NP-4
	46-60	Sandy loam, fine sandy loam.	SM	A-2	0-10	80-95	77-85	55-70	20-35	<20	NP-4
Histosols.											

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1055*: Aquolls.											
Histosols.											
1926*: Bowstring-------	0-18	Muck-------------	PT	A-8	0	---	---	---	---	---	---
	18-23	Sand, fine sand, fine sandy loam.	SP-SM, SM	A-2	0	100	100	50-85	10-35	<20	NP-5
	23-36	Sapric material	PT	A-8	0	---	---	---	---	---	---
	36-60	Sand-------------	SP-SM, SM	A-2	0	100	100	50-85	10-35	<20	NP-5
Aquents.											
1927------------- Clotho	0-16	Sandy loam-------	SM-SC, SC	A-2, A-4, A-6	5-10	85-100	80-100	70-80	25-50	20-30	6-12
	16-26	Sandy loam, fine sandy loam.	SM, SM-SC, SC	A-4	5-10	85-95	80-95	65-80	35-45	<25	3-10
	26-60	Sandy loam-------	SM, SM-SC, SC	A-4	5-10	85-95	80-95	70-80	35-45	<25	3-8
1932------------- Runeberg	0-12	Sandy loam-------	SM-SC, SM, SC	A-2, A-4, A-6	5-10	85-100	80-95	65-80	25-45	20-30	5-15
	12-27	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	5-10	85-95	80-95	60-75	30-45	15-25	3-10
	27-60	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-95	60-75	30-45	15-25	3-8
1943------------- Roscommon	0-9	Loamy sand-------	SM, SP-SM	A-2, A-3, A-4	0	100	95-100	50-75	5-40	---	NP
	9-60	Sand, loamy sand	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	85-100	40-70	0-15	---	NP
1956------------- Staples	0-6	Loamy sand-------	SM, SP-SM	A-2-4	0	90-100	80-95	65-80	10-30	<20	NP-4
	6-25	Loamy sand, sand, loamy fine sand.	SM, SP-SM	A-3, A-2-4, A-1-b	0-23	75-95	40-90	30-65	5-15	<20	NP-4
	25-44	Sandy loam-------	SM, SC, SM-SC	A-2-4, A-1-b	0-10	85-95	70-95	45-67	20-35	<25	NP-9
	44-60	Sandy loam-------	SM, SM-SC, SC	A-2-4, A-1-b	0-10	85-95	70-95	45-67	20-35	<25	NP-9

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
7A, 7B-----------	0-15	4-10	1.45-1.60	6.0-20	0.08-0.12	5.1-7.3	Low-----------	0.15	5	2	2-5
Hubbard	15-30	1-5	1.55-1.65	6.0-20	0.03-0.07	5.1-7.3	Low-----------	0.15			
	30-60	0-5	1.55-1.65	6.0-20	0.03-0.07	6.1-7.3	Low-----------	0.15			
36---------------	0-14	22-27	1.30-1.45	0.2-2.0	0.18-0.24	6.1-7.8	Moderate-----	0.28	5	6	5-8
Flom	14-24	24-35	1.45-1.60	0.2-0.6	0.15-0.19	6.6-8.4	Moderate-----	0.28			
	24-60	24-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	Moderate-----	0.28			
38B, 38C---------	0-10	12-27	1.25-1.40	0.2-2.0	0.17-0.24	6.1-7.3	Moderate-----	0.24	5	6	3-6
Waukon	10-31	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	Moderate-----	0.32			
	31-60	18-30	1.45-1.65	0.6-2.0	0.15-0.19	7.4-8.4	Low-----------	0.32			
53B, 53C, 53D----	0-6	5-18	1.35-1.60	0.6-6.0	0.13-0.18	5.1-6.5	Low-----------	0.20	5	3	2-4
Kandota	6-26	5-15	1.50-1.75	0.6-2.0	0.12-0.17	5.1-6.5	Low-----------	0.28			
	26-33	18-30	1.50-1.75	0.2-0.6	0.12-0.18	5.6-7.3	Moderate-----	0.28			
	33-60	7-18	1.70-1.95	0.2-0.6	0.11-0.16	7.4-8.4	Low-----------	0.28			
75---------------	0-20	14-25	1.25-1.40	0.6-2.0	0.20-0.24	5.6-6.5	Low-----------	0.28	5	5	3-7
Bluffton	20-44	18-30	1.45-1.55	0.6-6.0	0.15-0.17	5.6-7.3	Low-----------	0.28			
	44-60	18-27	1.50-1.65	0.2-0.6	0.15-0.19	7.4-8.4	Low-----------	0.28			
82B, 82C---------	0-3	2-6	1.45-1.60	6.0-20	0.10-0.12	5.1-7.3	Low-----------	0.15	4	2	1-3
Redeye	3-22	2-6	1.45-1.65	6.0-20	0.07-0.10	5.6-6.5	Low-----------	0.15			
	22-35	6-18	1.65-1.80	0.2-0.6	0.11-0.13	5.1-7.3	Low-----------	0.28			
	35-60	5-14	1.80-2.00	<0.06	0	7.4-8.4	Low-----------	0.28			
111--------------	0-14	8-18	1.25-1.45	2.0-20	0.10-0.14	6.6-7.8	Low-----------	0.20	2	3	3-8
Hangaard	14-18	5-15	1.50-1.70	6.0-20	0.07-0.11	6.6-7.8	Low-----------	0.20			
	18-60	2-10	1.50-1.70	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
121--------------	0-7	5-18	1.30-1.55	0.6-6.0	0.13-0.18	5.1-6.5	Low-----------	0.20	5	3	2-6
Wykeham	7-19	5-15	1.50-1.75	0.6-2.0	0.10-0.17	5.1-6.5	Low-----------	0.28			
	19-28	18-30	1.50-1.75	0.2-2.0	0.12-0.18	5.6-7.3	Moderate-----	0.28			
	28-60	10-18	1.70-1.95	0.2-0.6	0.11-0.16	7.4-8.4	Low-----------	0.28			
127A, 127B-------	0-14	10-18	1.35-1.50	2.0-6.0	0.13-0.15	6.1-7.3	Low-----------	0.20	3	3	2-4
Sverdrup	14-28	6-18	1.40-1.55	2.0-6.0	0.08-0.14	6.1-7.8	Low-----------	0.20			
	28-60	0-10	1.50-1.65	6.0-20	0.02-0.06	7.4-8.4	Low-----------	0.15			
139B-------------	0-6	2-6	1.45-1.60	6.0-20	0.10-0.12	5.1-7.3	Low-----------	0.17	4	2	1-3
Huntersville	6-27	2-6	1.45-1.65	6.0-20	0.04-0.10	5.1-6.5	Low-----------	0.15			
	27-53	6-18	1.65-1.80	0.2-0.6	0.11-0.13	5.1-7.3	Low-----------	0.20			
	53-60	6-15	1.80-2.00	<0.06	0	6.6-7.8	Low-----------	0.20			
142--------------	0-5	4-12	1.40-1.60	2.0-6.0	0.13-0.18	4.5-5.5	Low-----------	0.20	5	3	3-6
Nokay	5-18	5-15	1.45-1.70	0.6-6.0	0.12-0.19	4.5-5.5	Low-----------	0.28			
	18-28	8-18	1.45-1.80	0.6-2.0	0.12-0.19	5.1-6.5	Low-----------	0.28			
	28-60	4-18	1.75-1.90	<0.06	0.03-0.08	5.1-7.3	Low-----------	0.28			
144B, 144C-------	0-8	5-18	1.40-1.60	2.0-6.0	0.13-0.18	4.5-6.5	Low-----------	0.28	3	3	.5-2
Flak	8-14	5-18	1.45-1.70	2.0-6.0	0.12-0.16	5.1-6.5	Low-----------	0.28			
	14-33	8-18	1.45-1.80	0.6-2.0	0.12-0.16	5.1-6.5	Low-----------	0.28			
	33-60	4-18	1.80-2.00	<0.06	0.-0.04	5.6-6.5	Low-----------	0.28			
158B, 158C-------	0-4	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low-----------	0.17	5	2	.5-1
Zimmerman	4-60	2-10	1.50-1.70	6.0-20	0.06-0.10	5.1-7.3	Low-----------	0.17			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
163B	0-8	8-18	1.40-1.60	2.0-6.0	0.13-0.18	4.5-6.0	Low	0.28	4	3	.5-4
Brainerd	8-18	5-15	1.45-1.70	2.0-6.0	0.12-0.16	4.5-6.0	Low	0.28			
	18-36	8-18	1.45-1.80	0.6-2.0	0.12-0.16	5.1-6.5	Low	0.28			
	36-42	4-18	1.75-1.90	<0.06	0.03-0.08	5.1-7.3	Low	0.28			
	42-60	4-18	1.80-2.00	<0.06	0.-0.04	5.6-7.3	Low	0.28			
169B	0-9	2-10	1.40-1.60	2.0-6.0	0.08-0.10	5.6-7.3	Low	0.17	5	2	.5-2
Braham	9-24	2-10	1.40-1.70	6.0-20	0.06-0.09	5.6-7.3	Low	0.17			
	24-40	18-35	1.50-1.70	0.6-2.0	0.10-0.15	5.1-7.3	Low	0.32			
	40-60	18-35	1.55-1.80	0.6-2.0	0.08-0.14	7.4-8.4	Low	0.32			
170	0-9	2-10	1.40-1.60	6.0-20	0.08-0.12	5.1-7.3	Low	0.17	5	2	1-4
Blomford	9-31	2-10	1.40-1.70	6.0-20	0.05-0.08	5.1-7.3	Low	0.17			
	31-48	18-30	1.65-1.80	0.6-2.0	0.13-0.17	5.1-7.3	Moderate	0.37			
	48-60	18-30	1.65-1.80	0.6-2.0	0.10-0.15	5.1-8.4	Low	0.37			
180	0-12	10-27	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.24	5	6	2-5
Gonvick	12-32	22-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.3	Moderate	0.32			
	32-60	18-35	1.40-1.65	0.6-2.0	0.15-0.19	7.4-8.4	Low	0.32			
183	0-9	6-18	1.30-1.45	2.0-6.0	0.16-0.20	5.6-7.3	Low	0.20	5	3	3-15
Dassel	9-31	2-6	1.40-1.60	2.0-6.0	0.12-0.17	5.6-7.3	Low	0.20			
	31-60	2-8	1.45-1.65	6.0-20	0.08-0.10	6.1-7.8	Low	0.20			
200B, 200C	0-6	7-15	1.30-1.50	0.6-2.0	0.13-0.15	5.1-7.3	Low	0.24	5	3	1-3
Holdingford	6-13	7-15	1.40-1.60	0.6-2.0	0.11-0.14	5.1-7.3	Low	0.24			
	13-47	10-18	1.60-1.80	0.6-2.0	0.12-0.19	5.1-7.3	Low	0.24			
	47-60	9-14	1.60-1.80	0.6-2.0	0.12-0.14	7.4-8.4	Low	0.24			
202	0-8	4-10	1.35-1.65	6.0-20	0.10-0.12	5.1-7.3	Low	0.17	5	2	.5-3
Meehan	8-35	4-9	1.60-1.70	6.0-20	0.06-0.11	5.1-7.3	Low	0.17			
	35-60	1-4	1.60-1.70	6.0-20	0.02-0.07	5.1-7.3	Low	0.17			
204B, 204C, 204E	0-3	6-14	1.35-1.65	0.6-2.0	0.10-0.22	5.1-7.3	Low	0.24	5	3	1-2
Cushing	3-17	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-6.5	Low	0.32			
	17-54	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-6.5	Low	0.32			
	54-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-7.3	Low	0.32			
207B, 207C	0-9	2-12	1.45-1.60	6.0-20	0.10-0.12	5.1-6.5	Low	0.17	5	2	1-3
Nymore	9-60	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.3	Low	0.17			
260	0-15	2-10	1.40-1.60	6.0-20	0.08-0.12	5.6-7.3	Low	0.15	5	2	2-6
Duelm	15-44	1-8	1.55-1.65	6.0-20	0.06-0.11	5.1-7.3	Low	0.15			
	44-60	0-6	1.55-1.65	6.0-20	0.02-0.07	5.6-7.3	Low	0.15			
261	0-19	2-8	1.30-1.60	6.0-20	0.08-0.12	5.6-7.3	Low	0.17	5	2	3-8
Isan	19-27	2-8	1.50-1.65	6.0-20	0.06-0.10	5.1-6.5	Low	0.17			
	27-60	1-5	1.55-1.70	6.0-20	0.04-0.06	5.6-7.3	Low	0.17			
292	0-9	7-14	1.50-1.60	0.6-2.0	0.13-0.18	5.1-7.3	Low	0.24	5	3	1-3
Alstad	9-14	6-16	1.55-1.65	0.6-2.0	0.13-0.22	5.1-7.3	Low	0.32			
	14-34	18-35	1.55-1.65	0.6-2.0	0.14-0.22	5.1-7.3	Low	0.32			
	34-48	18-35	1.55-1.70	0.6-2.0	0.13-0.19	5.6-7.8	Low	0.32			
	48-60	8-23	1.60-1.80	0.2-0.6	0.09-0.19	5.6-8.4	Low	0.32			
325	0-12	5-20	1.35-1.55	2.0-6.0	0.16-0.18	5.6-7.3	Low	0.20	5	3	4-8
Prebish	12-45	12-18	1.50-1.70	0.2-2.0	0.14-0.16	5.6-7.3	Low	0.28			
	45-60	2-15	1.65-1.90	0.2-0.6	0.09-0.13	5.6-8.4	Low	0.28			
341A, 341B, 341C	0-11	6-18	1.40-1.60	2.0-6.0	0.13-0.15	6.1-8.4	Low	0.20	3	3	1-4
Arvilla	11-21	6-18	1.40-1.60	2.0-6.0	0.11-0.14	6.1-8.4	Low	0.20			
	21-60	2-10	1.40-1.60	>6.0	0.02-0.05	6.1-8.4	Low	0.10			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
374B, 374C, 374D-	0-8	5-15	1.55-1.80	0.6-2.0	0.13-0.18	5.1-6.5	Low----------	0.24	4	3	2-4
Rockwood	8-16	5-10	1.60-1.80	0.6-2.0	0.12-0.15	5.1-6.5	Low----------	0.24			
	16-37	8-18	1.60-1.75	0.6-2.0	0.12-0.15	5.6-7.3	Low----------	0.24			
	37-46	8-18	1.65-1.80	0.2-0.6	0.12-0.15	5.6-7.3	Low----------	0.24			
	46-60	7-15	1.80-2.00	<0.06	0.-0.07	6.1-8.4	Low----------	0.24			
375--------------	0-18	8-18	1.30-1.50	2.0-6.0	0.13-0.15	6.1-7.8	Low----------	0.20	4	3	3-8
Forada	18-33	8-18	1.30-1.50	2.0-6.0	0.12-0.19	6.1-7.8	Low----------	0.28			
	33-60	0-5	1.50-1.70	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.15			
402C, 402E-------	0-8	3-10	1.40-1.50	2.0-6.0	0.08-0.12	6.6-8.4	Low----------	0.17	2	2	1-2
Sioux	8-60	0-10	1.60-1.75	>6.0	0.03-0.06	7.4-8.4	Low----------	0.10			
406B, 406C-------	0-8	4-18	1.40-1.55	2.0-6.0	0.13-0.15	5.6-7.3	Low----------	0.24	3	3	3-5
Dorset	8-14	10-18	1.45-1.65	2.0-6.0	0.12-0.19	5.6-7.3	Low----------	0.24			
	14-34	5-10	1.55-1.65	6.0-20	0.06-0.10	5.6-7.8	Low----------	0.10			
	34-60	0-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10			
413--------------	0-13	8-18	1.30-1.50	2.0-6.0	0.14-0.18	6.1-7.3	Low----------	0.28	3	3	2-4
Osakis	13-17	8-18	1.30-1.50	0.6-6.0	0.14-0.19	6.1-7.3	Low----------	0.28			
	17-60	0-5	1.50-1.70	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10			
421B, 421C-------	0-14	20-27	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low----------	0.24	5	6	2-6
Ves	14-26	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate-----	0.24			
	26-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
446--------------	0-12	22-27	1.20-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.24	5	6	4-8
Normania	12-29	22-32	1.30-1.40	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.24			
	29-60	22-32	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.32			
453B, 453C-------	0-3	2-6	1.50-1.68	6.0-20	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	.5-1
DeMontreville	3-23	1-6	1.55-1.75	6.0-20	0.06-0.09	5.6-7.3	Low----------	0.17			
	23-48	6-22	1.70-1.80	0.2-0.6	0.08-0.14	5.6-6.5	Low----------	0.28			
	48-60	5-10	1.75-1.85	0.2-0.6	0.06-0.10	5.6-7.3	Low----------	0.28			
454B-------------	0-11	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
Mahtomedi	11-30	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	30-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
454C, 454E-------	0-2	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
Mahtomedi	2-25	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	25-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
458B, 458C, 458E-	0-3	2-10	1.20-1.50	6.0-20	0.10-0.12	4.5-6.5	Low----------	0.15	5	2	.5-2
Menahga	3-29	0-5	1.50-1.65	6.0-20	0.05-0.07	4.5-6.5	Low----------	0.15			
	29-60	0-5	1.50-1.65	6.0-20	0.05-0.07	5.6-7.3	Low----------	0.15			
514--------------	0-9	---	0.10-0.20	0.2-6.0	0.35-0.45	5.6-7.8	-------------	----	2	2	>75
Tacoosh	9-30	---	0.10-0.20	0.6-6.0	0.45-0.55	5.6-7.8	-------------	----			
	30-60	5-35	1.40-2.00	0.6-2.0	0.12-0.20	5.6-8.4	Low----------	----			
540--------------	0-10	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-8.4	-------------	----	2	2	>25
Seelyeville	10-60	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-8.4	-------------	----			
541--------------	0-9	---	0.20-0.35	>0.2	0.45-0.65	5.6-7.3	-------------	----	---	3	---
Rifle	9-60	---	0.08-0.20	0.6-6.0	0.45-0.55	5.6-7.3	-------------	----			
543--------------	0-38	---	0.15-0.45	0.2-6.0	0.35-0.45	5.6-7.8	-------------	----	2	2	55-85
Markey	38-60	0-10	1.40-1.65	6.0-20	0.03-0.08	5.6-8.4	Low----------	----			
544--------------	0-12	---	0.28-0.45	0.2-6.0	0.45-0.55	4.5-7.8	-------------	----	2	2	60-85
Cathro	12-30	---	0.15-0.30	0.2-6.0	0.35-0.45	4.5-7.8	-------------	----			
	30-60	10-25	1.50-1.70	0.2-2.0	0.11-0.22	6.1-8.4	Low----------	----			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
545--------------	0-30	0-10	0.10-0.25	0.2-6.0	0.35-0.48	5.1-7.8	-------------	----	2	2	>25
Rondeau	30-60	5-15	0.10-0.45	<0.2	0.20-0.22	7.4-7.8	-------------	----			
565--------------	0-9	5-15	1.30-1.70	2.0-6.0	0.10-0.12	6.1-7.3	Low-----------	0.17	5	2	1-3
Eckvoll	9-27	2-10	1.30-1.70	2.0-6.0	0.06-0.08	6.1-7.3	Low-----------	0.17			
	27-39	18-35	1.40-1.70	0.6-2.0	0.16-0.18	6.6-7.8	Moderate-----	0.32			
	39-60	18-32	1.30-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32			
571--------------	0-19	10-18	1.20-1.30	2.0-6.0	0.13-0.15	7.4-8.4	Low-----------	0.20	5	3	6-10
Coriff	19-35	2-18	1.35-1.45	2.0-6.0	0.12-0.15	7.4-8.4	Low-----------	0.20			
	35-60	18-35	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
572--------------	0-15	10-18	1.30-1.50	2.0-6.0	0.13-0.15	6.1-7.3	Low-----------	0.20	5	3	4-7
Lowlein	15-20	1-10	1.55-1.65	6.0-20	0.06-0.11	6.1-7.3	Low-----------	0.15			
	20-31	10-18	1.35-1.45	2.0-6.0	0.12-0.14	6.1-7.3	Low-----------	0.24			
	31-60	18-32	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
582--------------	0-16	18-27	1.10-1.50	0.2-2.0	0.17-0.24	6.6-7.8	Moderate-----	0.28	5	6	3-7
Roliss	16-24	18-35	1.30-1.70	0.2-2.0	0.15-0.19	6.6-7.8	Moderate-----	0.28			
	24-60	18-35	1.30-1.70	0.2-2.0	0.15-0.19	7.9-8.4	Moderate-----	0.28			
701--------------	0-10	10-18	1.45-1.60	0.6-2.0	0.13-0.22	6.1-7.3	Low-----------	0.20	5	3	4-10
Runeberg	10-26	10-18	1.60-1.80	0.2-0.6	0.12-0.18	6.1-7.3	Low-----------	0.28			
	26-60	6-15	1.75-1.90	0.06-0.6	0.06-0.13	7.4-8.4	Low-----------	0.28			
703--------------	0-9	8-15	1.45-1.75	0.6-2.0	0.13-0.18	5.6-7.3	Low-----------	0.24	5	3	2-6
Paddock	9-22	3-10	1.50-1.75	0.6-2.0	0.12-0.16	5.6-7.3	Low-----------	0.24			
	22-43	8-18	1.60-1.80	0.2-0.6	0.12-0.16	5.6-7.3	Low-----------	0.24			
	43-60	6-15	1.80-2.00	<0.06	0.-0.07	7.4-8.4	Low-----------	0.24			
720B-------------	0-6	5-15	1.55-1.80	0.6-2.0	0.13-0.18	5.1-7.3	Low-----------	0.24	4	3	2-6
Blowers	6-17	5-10	1.60-1.80	0.6-2.0	0.12-0.15	5.1-6.5	Low-----------	0.24			
	17-27	8-18	1.60-1.75	0.6-2.0	0.12-0.15	5.6-7.3	Low-----------	0.24			
	27-40	8-18	1.65-1.80	0.2-0.6	0.12-0.15	5.6-7.8	Low-----------	0.24			
	40-60	7-15	1.80-2.00	0.06-0.2	0.-0.07	6.6-8.4	Low-----------	0.24			
800B*:											
Kandota---------	0-6	5-18	1.35-1.60	0.6-6.0	0.13-0.18	5.1-6.5	Low-----------	0.20	5	3	2-4
	6-26	5-15	1.50-1.75	0.6-2.0	0.12-0.17	5.1-6.5	Low-----------	0.28			
	26-33	18-30	1.50-1.75	0.2-2.0	0.12-0.18	5.6-7.3	Moderate-----	0.28			
	33-60	7-18	1.70-1.95	0.2-0.6	0.11-0.16	7.4-8.4	Low-----------	0.28			
Dorset----------	0-8	4-18	1.40-1.55	2.0-6.0	0.13-0.15	5.6-7.3	Low-----------	0.24	3	3	3-5
	8-15	10-18	1.45-1.65	2.0-6.0	0.12-0.19	5.6-7.3	Low-----------	0.24			
	15-34	5-10	1.55-1.65	6.0-20	0.06-0.10	5.6-7.8	Low-----------	0.10			
	34-60	0-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
800C*, 800E*:											
Kandota---------	0-6	5-18	1.35-1.60	0.6-6.0	0.13-0.18	5.1-6.5	Low-----------	0.20	5	3	2-4
	6-26	5-15	1.50-1.75	0.6-2.0	0.12-0.17	5.1-6.5	Low-----------	0.28			
	26-33	18-30	1.50-1.75	0.2-2.0	0.12-0.18	5.6-7.3	Moderate-----	0.28			
	33-60	7-18	1.70-1.95	0.2-0.6	0.11-0.16	7.4-8.4	Low-----------	0.28			
Dorset----------	0-8	4-18	1.40-1.55	2.0-6.0	0.13-0.15	5.6-7.3	Low-----------	0.24	3	3	3-5
	8-15	10-18	1.45-1.65	2.0-6.0	0.12-0.19	5.6-7.3	Low-----------	0.24			
	15-34	5-10	1.55-1.65	6.0-20	0.06-0.10	5.6-7.8	Low-----------	0.10			
	34-60	0-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
808*:											
Wykeham----------	0-8	5-18	1.30-1.55	0.6-6.0	0.13-0.18	5.1-6.5	Low-----------	0.20	5	3	2-6
	8-14	5-15	1.50-1.75	0.6-2.0	0.10-0.17	5.1-6.5	Low-----------	0.28			
	14-40	18-30	1.50-1.75	0.2-2.0	0.12-0.18	5.6-7.3	Moderate------	0.28			
	40-60	10-18	1.70-1.95	0.2-0.6	0.11-0.16	7.4-8.4	Low-----------	0.28			
Runeberg---------	0-12	10-18	1.45-1.60	0.6-2.0	0.13-0.18	6.1-7.3	Low-----------	0.20	4	3	4-10
	12-26	10-18	1.60-1.80	0.2-0.6	0.12-0.18	6.1-7.3	Low-----------	0.28			
	26-60	6-15	1.75-1.90	0.06-0.6	0.06-0.13	7.4-8.4	Low-----------	0.28			
823*:											
Hangaard---------	0-9	8-18	1.25-1.45	2.0-20	0.10-0.14	6.6-7.8	Low-----------	0.20	2	3	3-8
	9-14	5-15	1.50-1.70	6.0-20	0.07-0.11	6.6-7.8	Low-----------	0.20			
	14-60	2-10	1.50-1.70	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
Sioux------------	0-7	3-10	1.40-1.50	2.0-6.0	0.08-0.12	6.6-8.4	Low-----------	0.17	2	2	1-2
	7-60	0-10	1.60-1.75	>6.0	0.03-0.06	7.4-8.4	Low-----------	0.10			
824C*:											
Dorset-----------	0-8	4-18	1.40-1.55	2.0-6.0	0.13-0.15	5.6-7.3	Low-----------	0.24	3	3	3-5
	8-11	10-18	1.45-1.65	2.0-6.0	0.12-0.19	5.6-7.3	Low-----------	0.24			
	11-33	5-10	1.55-1.65	6.0-20	0.06-0.10	5.6-7.8	Low-----------	0.10			
	33-60	0-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
Sioux------------	0-6	10-18	1.25-1.40	2.0-6.0	0.11-0.15	6.6-8.4	Low-----------	0.20	2	3	1-3
	6-60	0-10	1.60-1.75	>6.0	0.03-0.06	7.4-8.4	Low-----------	0.10			
824E*:											
Dorset-----------	0-8	4-18	1.40-1.55	2.0-6.0	0.13-0.15	5.6-7.3	Low-----------	0.24	3	3	3-5
	8-11	10-18	1.45-1.65	2.0-6.0	0.12-0.19	5.6-7.3	Low-----------	0.24			
	11-33	5-10	1.55-1.65	6.0-20	0.06-0.10	5.6-7.8	Low-----------	0.10			
	33-60	0-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
Sioux------------	0-5	3-10	1.40-1.50	2.0-6.0	0.08-0.12	6.6-8.4	Low-----------	0.17	2	2	1-2
	5-60	0-10	1.60-1.75	>6.0	0.03-0.06	7.4-8.4	Low-----------	0.10			
825*:											
Gonvick----------	0-13	10-27	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Moderate------	0.24	5	6	2-5
	13-25	22-35	1.35-1.50	0.6-2.0	0.15-0.19	6.6-7.3	Moderate------	0.32			
	25-60	18-35	1.40-1.65	0.6-2.0	0.15-0.19	7.4-8.4	Low-----------	0.32			
Flom-------------	0-15	22-27	1.30-1.45	0.2-2.0	0.18-0.24	6.1-7.8	Moderate------	0.28	5	6	5-8
	15-30	24-35	1.45-1.60	0.2-0.6	0.15-0.19	6.6-8.4	Moderate------	0.28			
	30-60	24-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	Moderate------	0.28			
873*:											
Prebish----------	0-20	5-20	1.35-1.55	2.0-6.0	0.16-0.18	5.6-7.3	Low-----------	0.20	5	3	3-6
	20-30	12-18	1.50-1.70	0.2-2.0	0.14-0.16	5.6-7.3	Low-----------	0.28			
	30-60	2-15	1.65-1.90	0.2-0.6	0.09-0.13	5.6-8.4	Low-----------	0.28			
Nokay------------	0-7	4-12	1.40-1.60	2.0-6.0	0.13-0.18	4.5-5.5	Low-----------	0.20	5	3	3-6
	7-17	5-15	1.45-1.70	0.6-6.0	0.12-0.19	4.5-5.5	Low-----------	0.28			
	17-30	8-18	1.45-1.80	0.6-2.0	0.12-0.19	5.1-6.5	Low-----------	0.28			
	30-40	4-18	1.75-1.90	0.06-0.2	0.03-0.08	5.6-7.3	Low-----------	0.28			
	40-60	4-18	1.80-2.00	<0.2	0.-0.04	5.6-7.3	Low-----------	0.28			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
928B*, 928C*, 928E*:											
Cushing	0-3	6-14	1.35-1.65	0.6-2.0	0.10-0.22	5.1-7.3	Low	0.24	5	3	1-2
	3-17	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-6.5	Low	0.32			
	17-54	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-6.5	Low	0.32			
	54-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-7.3	Low	0.32			
DeMontreville	0-3	2-6	1.50-1.68	6.0-20	0.10-0.12	5.6-7.3	Low	0.17	5	2	.5-1
	3-23	1-6	1.55-1.75	6.0-20	0.06-0.09	5.6-7.3	Low	0.17			
	23-48	6-22	1.70-1.80	0.2-0.6	0.08-0.14	5.6-6.5	Low	0.28			
	48-60	5-10	1.75-1.85	0.2-0.6	0.06-0.10	5.6-7.3	Low	0.28			
Mahtomedi	0-5	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low	0.15	5	2	<1
	5-30	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low	0.10			
	30-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low	0.10			
967C*, 967D*:											
Waukon	0-8	12-27	1.25-1.40	0.2-2.0	0.17-0.24	6.1-7.3	Moderate	0.24	5	6	3-6
	8-26	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	Moderate	0.32			
	26-60	18-30	1.45-1.65	0.6-2.0	0.15-0.19	7.4-8.4	Low	0.32			
Langhei	0-10	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	Low	0.32	5	4L	.5-3
	10-60	18-32	1.50-1.65	0.6-2.0	0.15-0.19	7.4-8.4	Low	0.37			
1015. Psamments											
1029*. Pits											
1054*:											
Prebish	0-18	5-20	1.35-1.55	2.0-6.0	0.16-0.18	5.6-7.3	Low	0.20	5	3	4-8
	18-46	12-18	1.50-1.70	0.2-2.0	0.14-0.16	5.6-7.3	Low	0.28			
	46-60	2-15	1.65-1.90	0.2-0.6	0.09-0.13	5.6-8.4	Low	0.28			
Histosols.											
1055*: Aquolls.											
Histosols.											
1926*:											
Bowstring	0-18	0-5	0.15-0.30	0.2-6.0	0.35-0.45	5.6-8.4	-------------	----	---	8	40-90
	18-23	1-12	1.40-1.60	0.6-20	0.08-0.14	5.6-8.4	Low	----			
	23-36	0-5	0.15-0.30	0.2-6.0	0.35-0.45	5.6-8.4	-------------	----			
	36-60	1-12	1.40-1.80	0.6-2.0	0.08-0.14	5.6-8.4	Low	----			
Aquents.											
1927 Clotho	0-16	10-18	1.50-1.60	0.6-2.0	0.13-0.18	7.4-8.4	Low	0.20	4	5	4-8
	16-26	8-18	1.60-1.80	0.2-0.6	0.12-0.17	7.4-8.4	Low	0.28			
	26-60	6-15	1.75-1.90	0.2-0.6	0.06-0.14	7.4-8.4	Low	0.28			
1932 Runeberg	0-12	10-18	1.45-1.60	0.6-2.0	0.13-0.18	6.1-7.3	Low	0.20	4	3	4-10
	12-27	10-18	1.60-1.80	0.2-0.6	0.12-0.18	6.1-7.3	Low	0.28			
	27-60	6-15	1.75-1.90	0.06-0.6	0.06-0.13	7.4-8.4	Low	0.28			
1943 Roscommon	0-9	0-12	0.90-1.60	6.0-20	0.07-0.20	5.6-7.8	Low	0.17	5	2	4-15
	9-60	0-10	1.45-1.70	6.0-20	0.05-0.07	5.6-8.4	Low	0.17			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
1956-------------	0-6	2-6	1.45-1.60	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.15	4	2	2-8
Staples	6-25	2-6	1.45-1.60	6.0-20	0.07-0.10	5.1-7.3	Low----------	0.15			
	25-44	8-18	1.65-1.80	0.2-0.6	0.06-0.13	5.1-7.3	Low----------	0.20			
	44-60	6-15	1.80-2.00	<0.06	---	6.1-7.8	Low----------	0.20			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "frequent," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
7A, 7B----------- Hubbard	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
36---------------- Flom	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
38B, 38C---------- Waukon	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Low.
53B, 53C, 53D----- Kandota	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
75---------------- Bluffton	C/D	None--------	---	---	+2-2.0	Apparent	Jan-Dec	---	High-----	High-----	Moderate.
82B, 82C---------- Redeye	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Moderate.
111--------------- Hangaard	D	None--------	---	---	1.0-3.0	Apparent	Apr-Jul	---	Moderate	High-----	Low.
121--------------- Wykeham	B	None--------	---	---	2.5-5.0	Apparent	Apr-Jun	---	Moderate	Moderate	Moderate.
127A, 127B-------- Sverdrup	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
139B-------------- Huntersville	B	None--------	---	---	2.5-4.0	Perched	Mar-Dec	---	High-----	Moderate	Moderate.
142--------------- Nokay	C	None--------	---	---	1.0-3.0	Perched	Apr-Jun	---	High-----	Moderate	High.
144B, 144C-------- Flak	C	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
158B, 158C-------- Zimmerman	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	High.
163B-------------- Brainerd	C	None--------	---	---	1.5-2.5	Perched	Apr-Jun	---	Moderate	Moderate	Moderate.
169B-------------- Braham	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
170-------------- Blomford	B/D	None--------	---	---	0.5-1.5	Apparent	Apr-Jun	---	Moderate	High-----	Moderate.
180-------------- Gonvick	B	None--------	---	---	2.5-4.0	Apparent	Nov-Jun	---	High-----	Moderate	Low.
183-------------- Dassel	B/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	---	High-----	High-----	Low.
200B, 200C-------- Holdingford	C	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
202-------------- Meehan	B	None--------	---	---	1.0-3.0	Apparent	Oct-May	---	Moderate	Low------	Moderate.
204B, 204C, 204E-- Cushing	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Moderate.
207B, 207C-------- Nymore	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
260-------------- Duelm	A	None--------	---	---	2.0-5.0	Apparent	Mar-Jun	---	Moderate	Low------	Moderate.
261-------------- Isan	A/D	None--------	---	---	+.5-2.0	Apparent	Oct-Jun	---	Moderate	High-----	Moderate.
292-------------- Alstad	C	None--------	---	---	2.0-4.0	Perched	Apr-Jun	---	High-----	Moderate	Moderate.
325-------------- Prebish	C/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	---	High-----	High-----	Low.
341A, 341B, 341C-- Arvilla	A	None--------	---	---	>6.0	---	---	---	Low------	Moderate	Low.
374B, 374C, 374D-- Rockwood	C	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
375-------------- Forada	B/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jun	---	High-----	High-----	Low.
402C, 402E-------- Sioux	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
406B, 406C-------- Dorset	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
413-------------- Osakis	B	None--------	---	---	3.0-6.0	Apparent	Nov-Jun	---	Moderate	Low------	Low.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
421B, 421C-------- Ves	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
446--------------- Normania	B	None--------	---	---	2.5-6.0	Apparent	Mar-Jun	---	High-----	High-----	Low.
453B, 453C-------- DeMontreville	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
454B, 454C, 454E-- Mahtomedi	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	High.
458B, 458C, 458E-- Menahga	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
514--------------- Tacoosh	B/D	None--------	---	---	+1-1.0	Apparent	Sep-May	9-29	High-----	High-----	Moderate.
540--------------- Seelyeville	A/D	None--------	---	---	+1-2.0	Apparent	Jan-Dec	50-55	High-----	High-----	Moderate.
541--------------- Rifle	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
543--------------- Markey	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	25-30	High-----	High-----	Low.
544--------------- Cathro	A/D	None--------	---	---	+1-1.0	Apparent	Oct-Jun	19-22	High-----	High-----	Low.
545--------------- Rondeau	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	35	High-----	High-----	Low.
565--------------- Eckvoll	B	None--------	---	---	2.0-5.0	Apparent	Apr-Jun	---	High-----	Moderate	Low.
571--------------- Coriff	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
572--------------- Lowlein	B	None--------	---	---	2.5-5.0	Apparent	Mar-Jun	---	Moderate	Moderate	Low.
582--------------- Roliss	B/D	None--------	---	---	1.0-3.0	Apparent	Apr-Jul	---	High-----	High-----	Low.
701--------------- Runeberg	C/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	---	High-----	High-----	Low.
703--------------- Paddock	C/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Moderate.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
720B Blowers	B	None	---	---	2.0-3.0	Perched	Oct-Jun	---	High	Moderate	Moderate.
800B*, 800C*, 800E*:											
Kandota	B	None	---	---	>6.0	---	---	---	Moderate	Low	Moderate.
Dorset	B	None	---	---	>6.0	---	---	---	Low	Low	Moderate.
808*:											
Wykeham	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	---	Moderate	Moderate	Moderate.
Runeberg	C/D	None	---	---	0.5-2.0	Perched	Nov-Jul	---	High	High	Low.
823*:											
Hangaard	D	None	---	---	1.0-3.0	Apparent	Apr-Jul	---	Moderate	High	Low.
Sioux	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
824C*, 824E*:											
Dorset	B	None	---	---	>6.0	---	---	---	Low	Low	Moderate.
Sioux	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
825*:											
Gonvick	B	None	---	---	2.5-4.0	Apparent	Nov-Jun	---	High	Moderate	Low.
Flom	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
873*:											
Prebish	C/D	None	---	---	0.5-2.0	Apparent	Jan-Dec	---	High	High	Low.
Nokay	C	None	---	---	1.0-3.0	Perched	Apr-Jun	---	High	Moderate	High.
928B*, 928C*, 928E*:											
Cushing	B	None	---	---	>6.0	---	---	---	Moderate	Moderate	Moderate.
DeMontreville	B	None	---	---	>6.0	---	---	---	Low	Low	Moderate.
Mahtomedi	A	None	---	---	>6.0	---	---	---	Low	Low	High.
967C*, 967D*:											
Waukon	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Langhei	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
1015. Psamments											
1029*. Pits											
1054*:											
Prebish	C/D	None	---	---	+4-1.0	Apparent	Jan-Dec	---	High	High	Low.
Histosols.											
1055*:											
Aquolls.											
Histosols.											
1926*:											
Bowstring	A/D	Frequent	Long	Mar-Jun	0-2.0	Apparent	Oct-Jun	20-30	High	High	Low.
Aquents.											
1927 Clotho	C/D	None	---	---	0.5-3.0	Apparent	Apr-Jun	---	High	High	Low.
1932 Runeberg	C/D	None	---	---	1.0-3.0	Perched	Nov-Jul	---	High	High	Low.
1943 Roscommon	A/D	None	---	---	+1-1.0	Apparent	Sep-Jun	---	Moderate	High	Low.
1956 Staples	B/D	None	---	---	0.5-2.0	Perched	Nov-Jul	---	High	High	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Alstad	Fine-loamy, mixed Aquic Eutroboralfs
Aquents	Mixed, frigid Fluvaquents
Aquolls	Mixed, frigid Haplaquolls
Arvilla	Sandy, mixed Udic Haploborolls
Blomford	Loamy, mixed, frigid Arenic Ochraqualfs
Blowers	Coarse-loamy, mixed Aquic Eutroboralfs
Bluffton	Fine-loamy, mixed, frigid Typic Haplaquolls
*Bowstring	Euic Fluvaquentic Borosaprists
Braham	Loamy, mixed Arenic Eutroboralfs
Brainerd	Coarse-loamy, mixed Aquic Eutroboralfs
Cathro	Loamy, mixed, euic Terric Borosaprists
Clotho	Coarse-loamy, mixed (calcareous), frigid Typic Haplaquolls
*Coriff	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
Cushing	Fine-loamy, mixed Glossic Eutroboralfs
*Dassel	Coarse-loamy, mixed, mesic Typic Haplaquolls
DeMontreville	Loamy, mixed Arenic Eutroboralfs
*Dorset	Coarse-loamy, mixed Boralfic Udic Argiborolls
Duelm	Sandy, mixed Aquic Haploborolls
Eckvoll	Fine-loamy, mixed Aquic Eutroboralfs
*Flak	Coarse-loamy, mixed Typic Eutroboralfs
Flom	Fine-loamy, mixed, frigid Typic Haplaquolls
Forada	Coarse-loamy, mixed, frigid Typic Haplaquolls
Gonvick	Fine-loamy, mixed Aquic Argiborolls
Hangaard	Sandy, mixed, frigid Typic Haplaquolls
Histosols	Euic, frigid Histosols
Holdingford	Coarse-loamy, mixed Mollic Eutroboralfs
Hubbard	Sandy, mixed Udorthentic Haploborolls
Huntersville	Coarse-loamy, mixed Aquic Eutroboralfs
Isan	Sandy, mixed, frigid Typic Haplaquolls
Kandota	Fine-loamy, mixed Mollic Eutroboralfs
Langhei	Fine-loamy, mixed (calcareous), frigid Typic Udorthents
*Lowlein	Coarse-loamy, mixed, mesic Typic Hapludolls
Mahtomedi	Mixed, frigid Typic Udipsamments
Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Meehan	Mixed, frigid Aquic Udipsamments
Menahga	Mixed, frigid Typic Udipsamments
Nokay	Coarse-loamy, mixed, frigid Udollic Ochraqualfs
*Normania	Fine-loamy, mixed, mesic Aquic Haplustolls
Nymore	Mixed, frigid Typic Udipsamments
Osakis	Sandy, mixed Aquic Haploborolls
Paddock	Coarse-loamy, mixed, frigid Udollic Ochraqualfs
Prebish	Coarse-loamy, mixed, frigid Typic Haplaquolls
Psamments	Mixed, frigid Udipsamments
Redeye	Loamy, mixed Arenic Eutroboralfs
Rifle	Euic Typic Borohemists
Rockwood	Coarse-loamy, mixed Mollic Eutroboralfs
Roliss	Fine-loamy, mixed (calcareous), frigid Typic Haplaquolls
*Rondeau	Marly, euic Limnic Borosaprists
Roscommon	Mixed, frigid Mollic Psammaquents
Runeberg	Coarse-loamy, mixed, frigid Typic Haplaquolls
Seelyeville	Euic Typic Borosaprists
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Staples	Loamy, mixed, frigid Arenic Ochraqualfs
Sverdrup	Sandy, mixed Udic Haploborolls
Tacoosh	Loamy, mixed, euic Terric Borohemists
*Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Waukon	Fine-loamy, mixed Mollic Eutroboralfs
Wykeham	Fine-loamy, mixed Aquic Eutroboralfs
Zimmerman	Mixed, frigid Alfic Udipsamments

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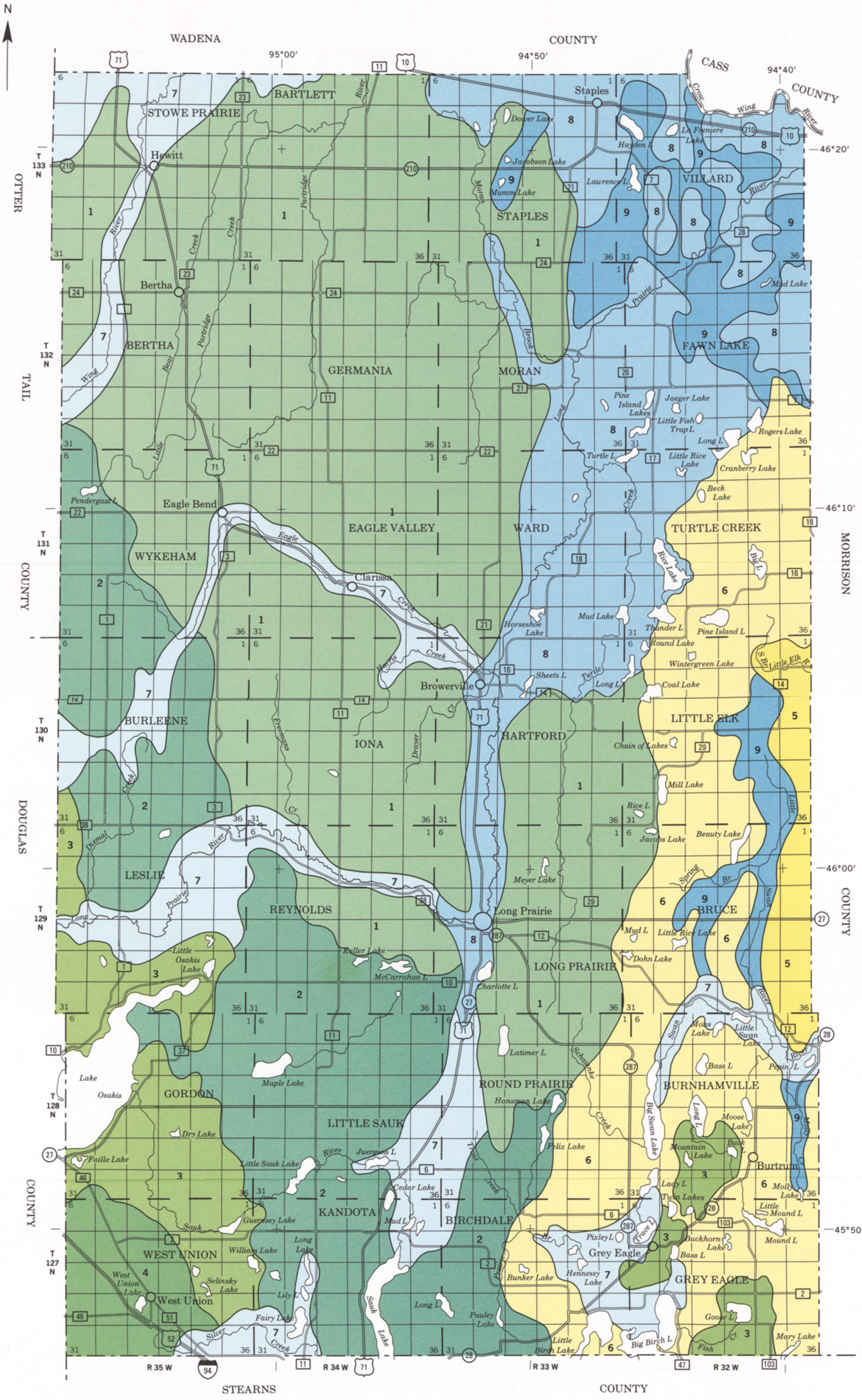
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VILLARD
BERTHA
GERMANIA
MORAN
FAWN LAKE
WYKEHAM
EAGLE VALLEY
WARD
TURTLE CREEK
BURLEENE
IONA
HARTFORD
LITTLE ELK
LESLIE
REYNOLDS
LONG PRAIRIE
BRUCE
GORDON
LITTLE SAUK
ROUND PRAIRIE
BURNHAMVILLE
WEST UNION
KANDOTA
BIRCHDALE
GREY EAGLE
Hewitt
Staples
Bertha
Eagle Bend
Clarissa
Browerville
Long Prairie
Burtrum
Grey Eagle
West Union
Dower Lake
Jacobson Lake
Mumm Lake
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La Freniere Lake
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Mud Lake
Pine Island Lakes
Jaeger Lake
Little Fish Trap L
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Turtle L
Little Rice Lake
Cranberry Lake
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Round Lake
Wintergreen Lake
Sheets L
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Coal Lake
Chain of Lakes
Mill Lake
Rice L
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Latimer L
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Little Swan Lake
Bass L
Pepin L
Lake Osakis
Maple Lake
Hansman Lake
Big Swan Lake
Long L
Moose Lake
Dry Lake
Faille Lake
Mountain Lake
Felix Lake
Little Sauk Lake
Juergens L
Cedar Lake
Lady L
Twin Lakes
Molly Lake
Little Mound L
Mound L
Guernsey Lake
Mud L
Pixley L
Buckhorn Lake
Bass L
William Lake
Long Lake
Hennessy Lake
Bunker Lake
West Union Lake
Selinsky Lake
Lily L
Long L
Pauley Lake
Goose L
Mary Lake
Fairy Lake
Little Birch Lake
Big Birch L
Wing River
Partridge River
Moran Brook
Crow Wing River
Prairie
Long Prairie River
Eagle Creek
Harris Creek
Turtle Creek
Drayer Cr
Freemans Creek
Dismal Creek
Little Elk R
Spring Br
Swan River
Schwinghammer Creek
Big Swan Creek
Trout Creek
Sauk River
Silver Creek
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LEGEND*

SOILS FORMED DOMINANTLY IN CALCAREOUS, LOAMY WADENA LOBE GLACIAL TILL

1 — Rockwood-Blowers-Paddock association: Nearly level to steep, well drained to somewhat poorly drained, loamy soils on drumlins and moraines

2 — Kandota-Wykeham-Runeberg association: Nearly level to steep, well drained, moderately well drained, poorly drained, and very poorly drained, loamy soils on moraines, drumlins, and uplands

SOILS FORMED DOMINANTLY IN CALCAREOUS, LOAMY DES MOINES LOBE GLACIAL TILL

3 — Roliss-Gonvick-Waukon association: Nearly level to steep, poorly drained, moderately well drained, and well drained, loamy soils on moraines and till plains

4 — Ves-Roliss-Normania association: Nearly level to sloping, well drained, poorly drained, and moderately well drained, loamy soils on ground moraines and till plains

SOILS FORMED DOMINANTLY IN LOAMY OR SANDY RAINY LOBE GLACIAL TILL OR IN ORGANIC DEPOSITS

5 — Flak-Rifle association: Nearly level to sloping, well drained and very poorly drained, loamy and mucky soils on moraines, drumlins, till plains, and outwash plains

6 — Cushing-DeMontreville-Rifle association: Nearly level to very steep, well drained and very poorly drained, loamy, sandy, or mucky soils on moraines, till plains, and outwash plains

SOILS FORMED DOMINANTLY IN LOAMY OUTWASH OVER SAND AND GRAVEL

7 — Forada-Dorset-Arvilla association: Nearly level to sloping, poorly drained, well drained, and somewhat excessively drained, loamy soils on outwash plains and moraines

SOILS FORMED DOMINANTLY IN SANDY OUTWASH OR ORGANIC DEPOSITS

8 — Menahga-Hubbard-Bowstring association: Nearly level to steep, excessively drained and very poorly drained, sandy or mucky soils on outwash plains and valley trains

9 — Roscommon-Meehan-Markey association: Nearly level, somewhat poorly drained to very poorly drained, sandy and mucky soils on outwash plains, stream terraces, and till plains

*Unless otherwise indicated, texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

Compiled 1987

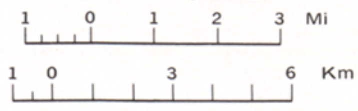
SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL
EXPERIMENT STATION

GENERAL SOIL MAP

TODD COUNTY, MINNESOTA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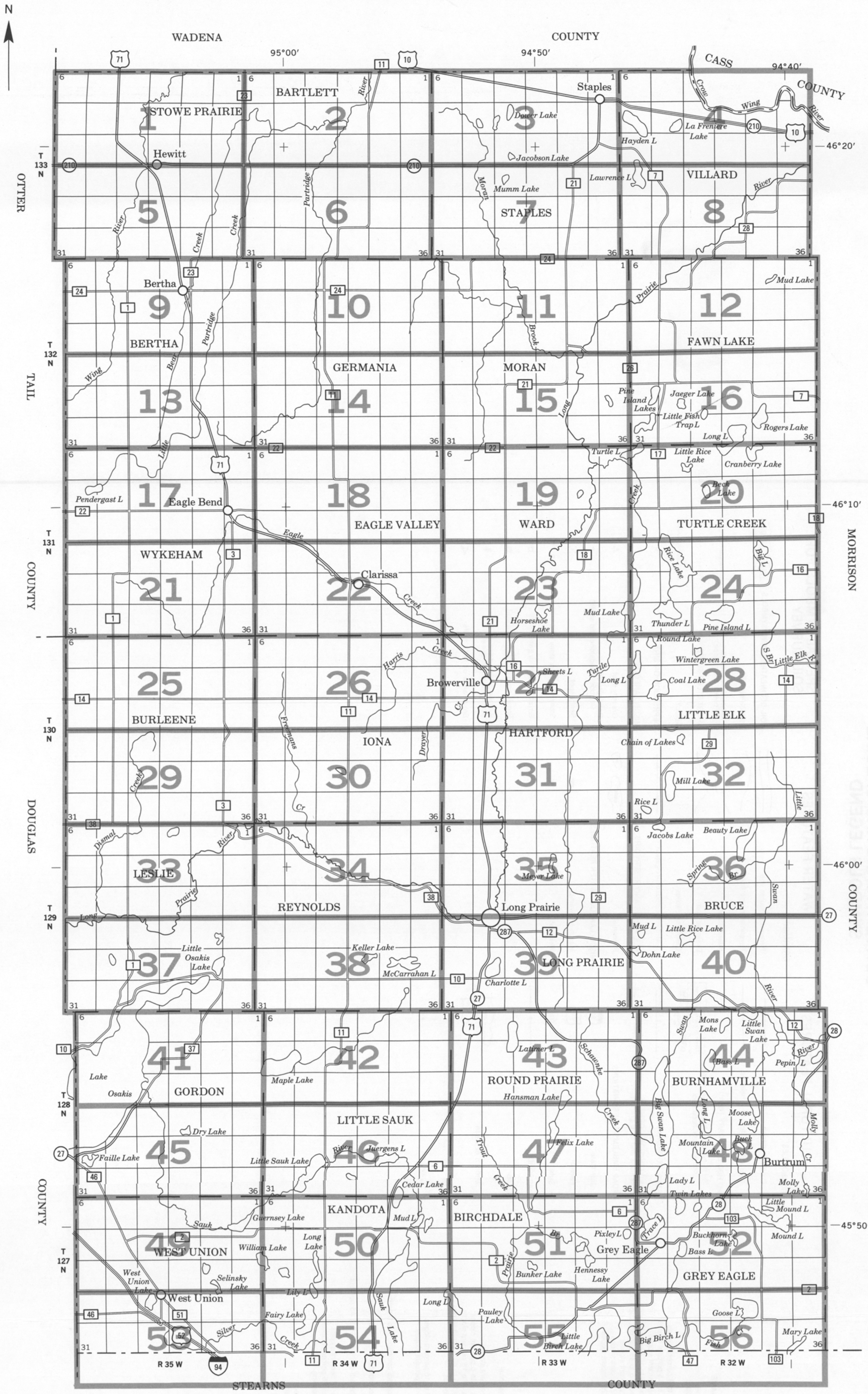
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.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LESLIE
REYNOLDS
BRUCE
LONG PRAIRIE
GORDON
LITTLE SAUK
ROUND PRAIRIE
BURNHAMVILLE
WEST UNION
KANDOTA
BIRCHDALE
GREY EAGLE
Staples
Hewitt
Bertha
Eagle Bend
Clarissa
Browerville
Long Prairie
Burtrum
Grey Eagle
West Union
Dower Lake
Jacobson Lake
Mumm Lake
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La Freniere Lake
Mud Lake
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Jaeger Lake
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Keller Lake
McCarrahan L
Charlotte L
Mons Lake
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Latimer L
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Pepin L
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Maple Lake
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Faille Lake
Little Sauk Lake
Juergens L
Felix Lake
Moose Lake
Mountain Lake
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Selinsky Lake
Lily L
Fairy Lake
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Pauley Lake
Little Birch Lake
Big Birch L
Goose L
Mary Lake
Big Swan Lake
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Partridge
Creek
Moran
Prairie
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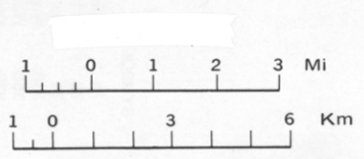
SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

TODD COUNTY, MINNESOTA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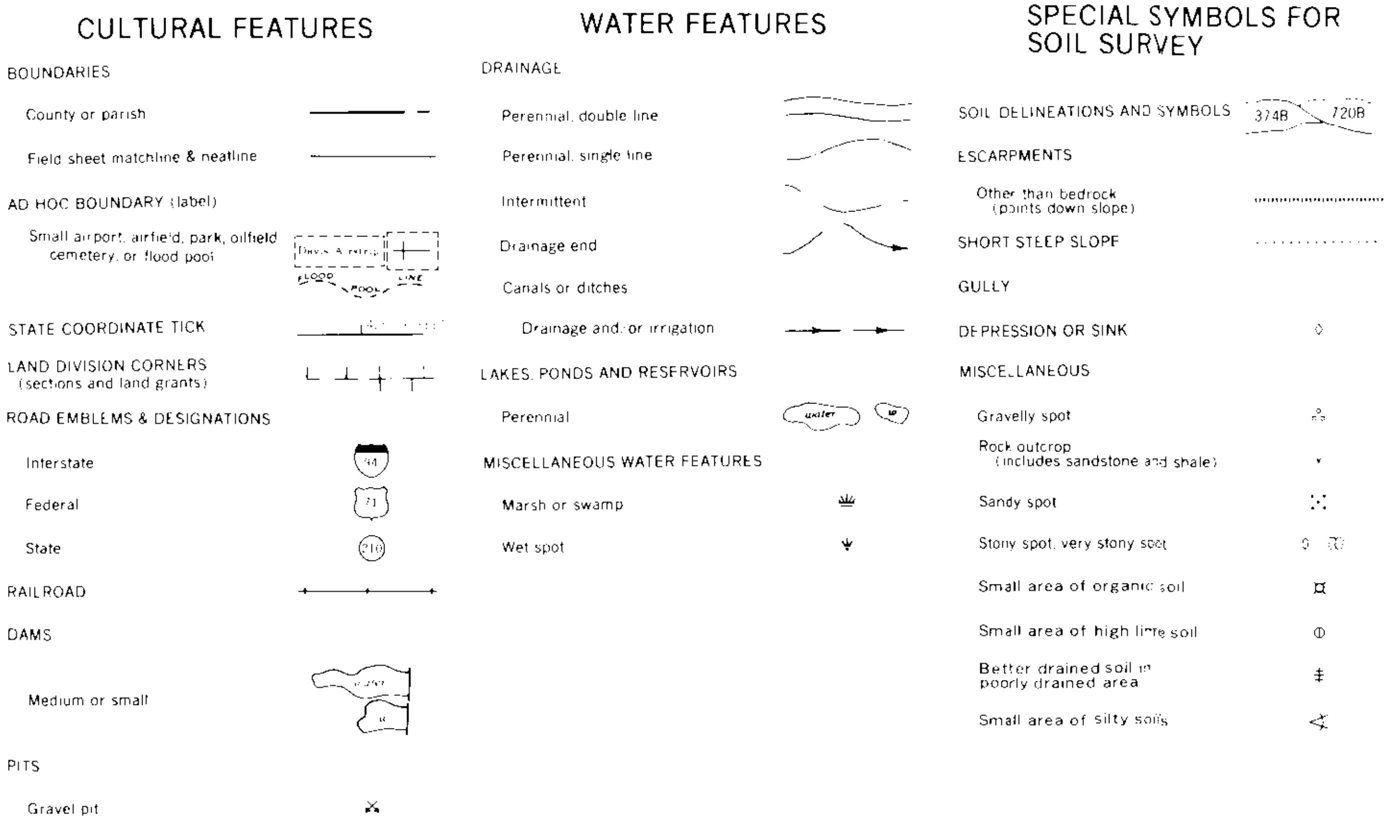
SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
7A	Hubbard loamy sand. 0 to 2 percent slopes
7B	Hubbard loamy sand. 2 to 6 percent slopes
36	Flom loam
38B	Waukon loam, 2 to 6 percent slopes
38C	Waukon loam, 6 to 12 percent slopes
53B	Kandota sandy loam, 2 to 6 percent slopes
53C	Kandota sandy loam, 6 to 12 percent slopes
53D	Kandota sandy loam. 12 to 25 percent slopes
75	Bluffton loam
82B	Redeye loamy sand, 2 to 6 percent slopes
82C	Redeye loamy sand, 6 to 12 percent slopes
111	Hangaard sandy loam
121	Wykeham fine sandy loam
127A	Sverdrup sandy loam. 0 to 2 percent slopes
127B	Sverdrup sandy loam, 2 to 6 percent slopes
139B	Huntersville loamy sand. 1 to 4 percent slopes
142	Nokay sandy loam
144B	Flak sandy loam. 2 to 6 percent slopes
144C	Flak sandy loam. 6 to 12 percent slopes
158B	Zimmerman loamy fine sand, 1 to 6 percent slopes
158C	Zimmerman loamy fine sand. 6 to 15 percent slopes
163B	Brainerd sandy loam, 1 to 4 percent slopes
169B	Braham loamy sand. 1 to 6 percent slopes
170	Blomford loamy sand
180	Gonvick loam
183	Dassel mucky sandy loam
200B	Holdingford sandy loam. 2 to 6 percent slopes
200C	Holdingford sandy loam. 6 to 12 percent slopes
202	Meehan loamy sand
204B	Cushing sandy loam. 2 to 8 percent slopes
204C	Cushing sandy loam. 8 to 15 percent slopes
204E	Cushing sandy loam. 15 to 45 percent slopes
207B	Nymore loamy sand, 1 to 6 percent slopes
207C	Nymore loamy sand, 6 to 12 percent slopes
260	Duelm loamy sand
261	Isan loamy sand
292	Alstad sandy loam
325	Prebish fine sandy loam
341A	Arvilla sandy loam, 0 to 2 percent slopes
341B	Arvilla sandy loam. 2 to 6 percent slopes
341C	Arvilla sandy loam, 6 to 12 percent slopes
374B	Rockwood sandy loam. 2 to 6 percent slopes
374C	Rockwood sandy loam, 6 to 12 percent slopes
374D	Rockwood sandy loam, 12 to 25 percent slopes
375	Forada sandy loam
402C	Sioux loamy sand, 2 to 12 percent slopes
402E	Sioux loamy sand, 12 to 25 percent slopes
406B	Dorset sandy loam. 2 to 6 percent slopes
406C	Dorset sandy loam. 6 to 12 percent slopes
413	Osakis sandy loam
421B	Ves loam, 2 to 6 percent slopes
421C	Ves loam. 6 to 12 percent slopes
446	Normania loam
453B	DeMontreville loamy sand, 2 to 8 percent slopes
453C	DeMontreville loamy sand. 8 to 15 percent slopes
454B	Mahtomedi loamy sand, 1 to 8 percent slopes
454C	Mahtomedi loamy coarse sand. 8 to 15 percent slopes
454E	Mahtomedi loamy coarse sand. 15 to 45 percent slopes
458B	Menahga loamy sand. 2 to 6 percent slopes
458C	Menahga loamy sand. 6 to 12 percent slopes
458E	Menahga loamy sand. 12 to 25 percent slopes
514	Tacoosh mucky peat
540	Seelyeville muck
541	Rifle muck
543	Markey muck
544	Cathro muck
545	Rondeau muck
565	Eckvoll loamy sand
571	Coriff sandy loam
572	Lowlein sandy loam
582	Roliss loam
701	Runeberg sandy loam, depressional
703	Paddock sandy loam
720B	Blowers sandy loam, 1 to 5 percent slopes
800B	Kandota-Dorset sandy loams. 2 to 6 percent slopes
800C	Kandota-Dorset sandy loams. 6 to 15 percent slopes
800E	Kandota-Dorset sandy loams. 15 to 40 percent slopes
808	Wykeham Runeberg sandy loams
823	Hangaard-Sioux complex
824C	Dorset-Sioux sandy loams. 6 to 15 percent slopes
824E	Dorset-Sioux complex. 15 to 30 percent slopes
825	Gonvick Flom loams
873	Prebish-Nokay sandy loams
928B	Cushing-DeMontreville-Mahtomedi complex, 2 to 8 percent slopes
928C	Cushing DeMontreville-Mahtomedi complex, 8 to 15 percent slopes
928E	Cushing-DeMontreville-Mahtomedi complex, 15 to 45 percent slopes
967C	Waukon Langhei loams. 4 to 12 percent slopes
967D	Waukon-Langhei loams, 12 to 25 percent slopes
1015	Psamments, nearly level to sloping
1029	Pits. gravel
1054	Prebish and Histosols, ponded
1055	Aquolls and Histosols, ponded
1926	Bowstring-Aquents complex
1927	Clotho sandy loam
1932	Runeberg sandy loam
1943	Roscommon loamy sand
1956	Staples loamy sand

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND



CULTURAL FEATURES

BOUNDARIES

County or parish

Field sheet matchline & neatline

AD HOC BOUNDARY (label)

Small airport, airfield, park, oilfield cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROAD EMBLEMS & DESIGNATIONS

Interstate

Federal

State

RAILROAD

DAMS

Medium or small

PITS

Gravel pit

WATER FEATURES

DRAINAGE

Perennial, double line

Perennial, single line

Intermittent

Drainage end

Canals or ditches

Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

Perennial

MISCELLANEOUS WATER FEATURES

Marsh or swamp

Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

MISCELLANEOUS

Gravelly spot

Rock outcrop (includes sandstone and shale)

Sandy spot

Stony spot, very stony spot

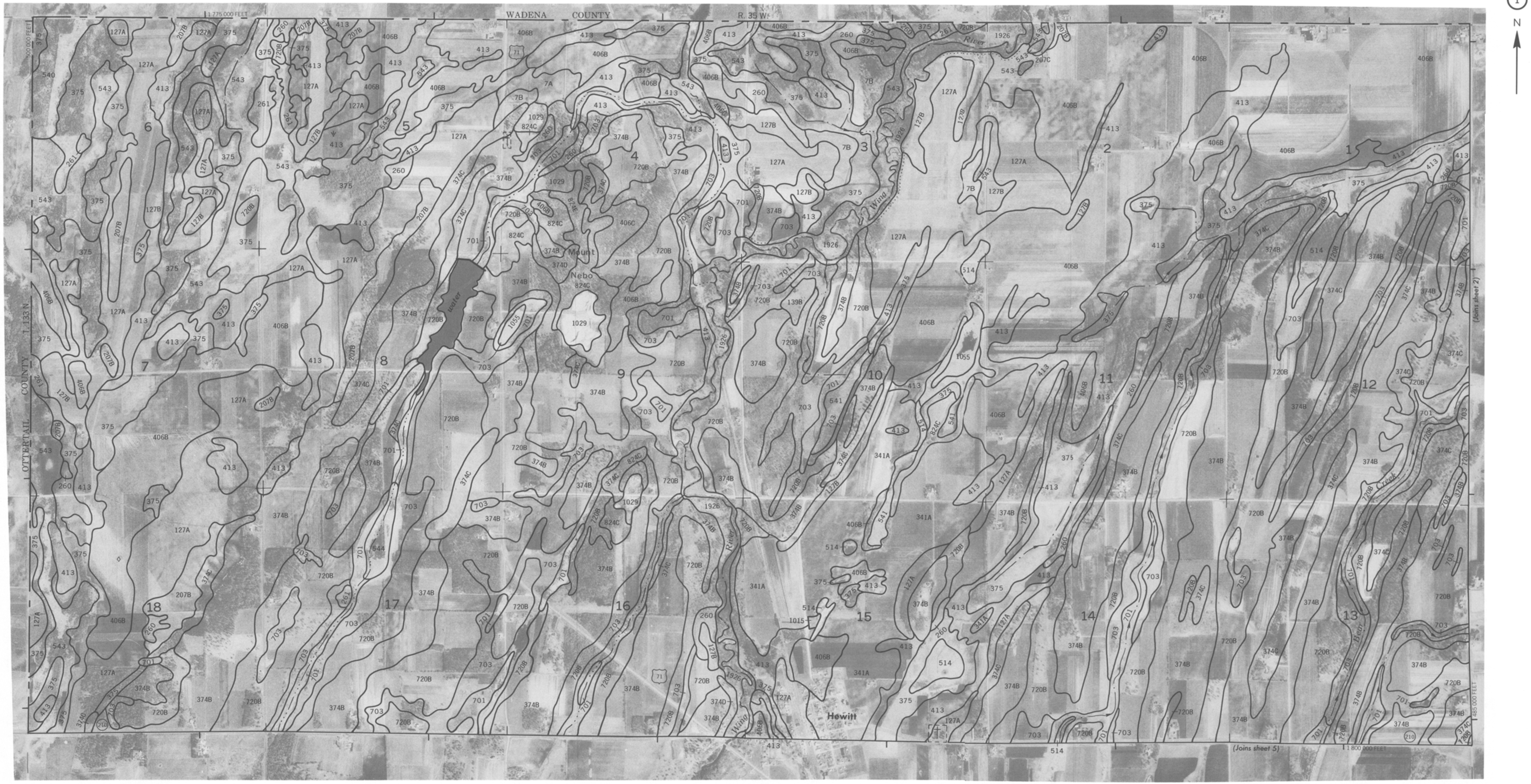
Small area of organic soil

Small area of high lime soil

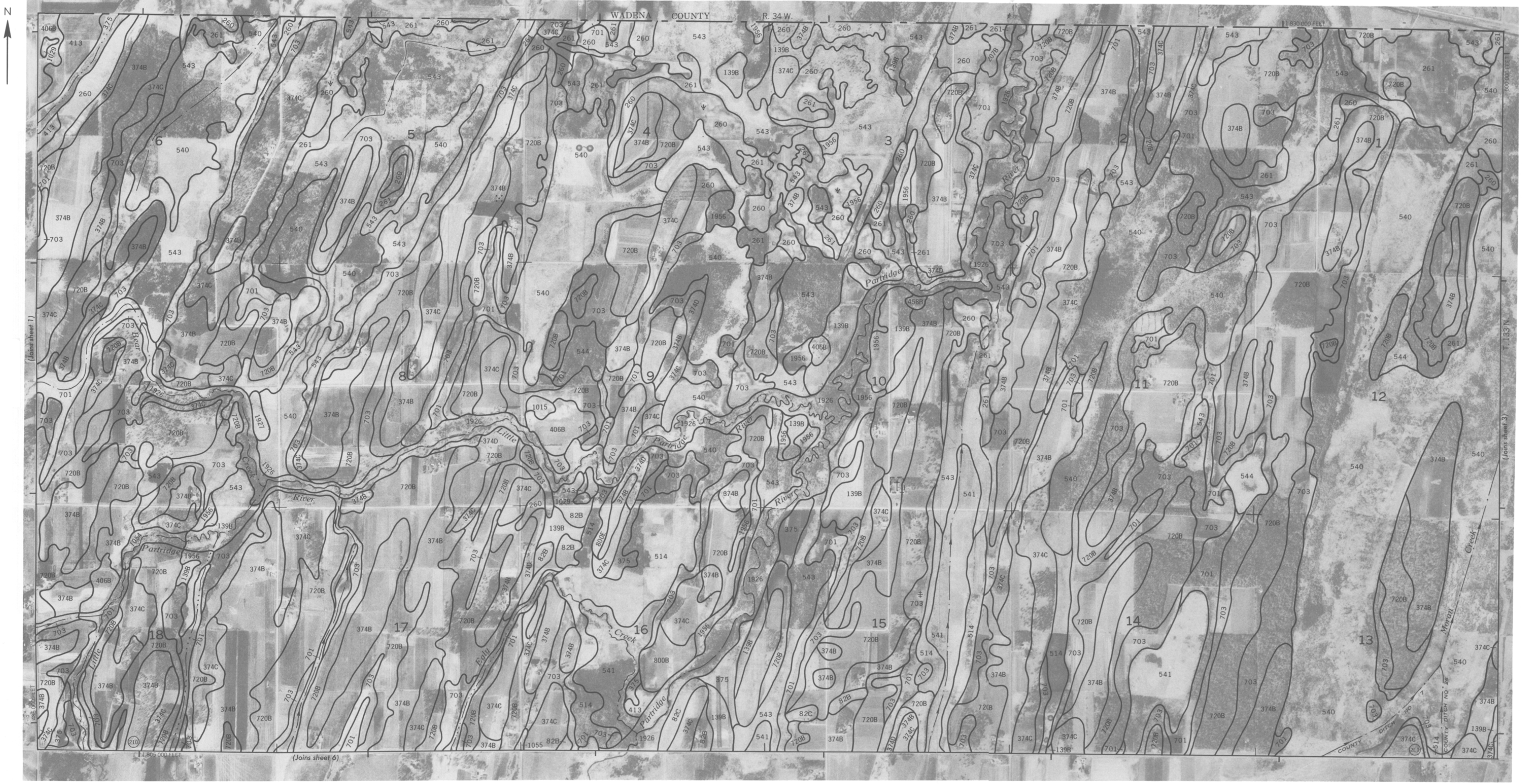
Better drained soil in poorly drained area

Small area of silty soils

TODD COUNTY, MINNESOTA — SHEET NUMBER 1


①
N
WADENA COUNTY
OTTERTAIL COUNTY
R. 35 W.
T. 133 N.
1 775 000 FEET
500 000 FEET
1 800 000 FEET
485 000 FEET
(Joins sheet 2)
(Joins sheet 5)
Mount
Nebo
water
Wing
River
Bear
Creek
Hewitt
71
210

TODD COUNTY, MINNESOTA — SHEET NUMBER 2


N
WADENA COUNTY
R. 34 W.
1 830 000 FEET
T. 133 N.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 6)
1 805 000 FEET
Partridge River
Little Partridge River
Little Creek
Eagle Creek
Moran Creek
County Ditch No. 28
210
1
2
3
4
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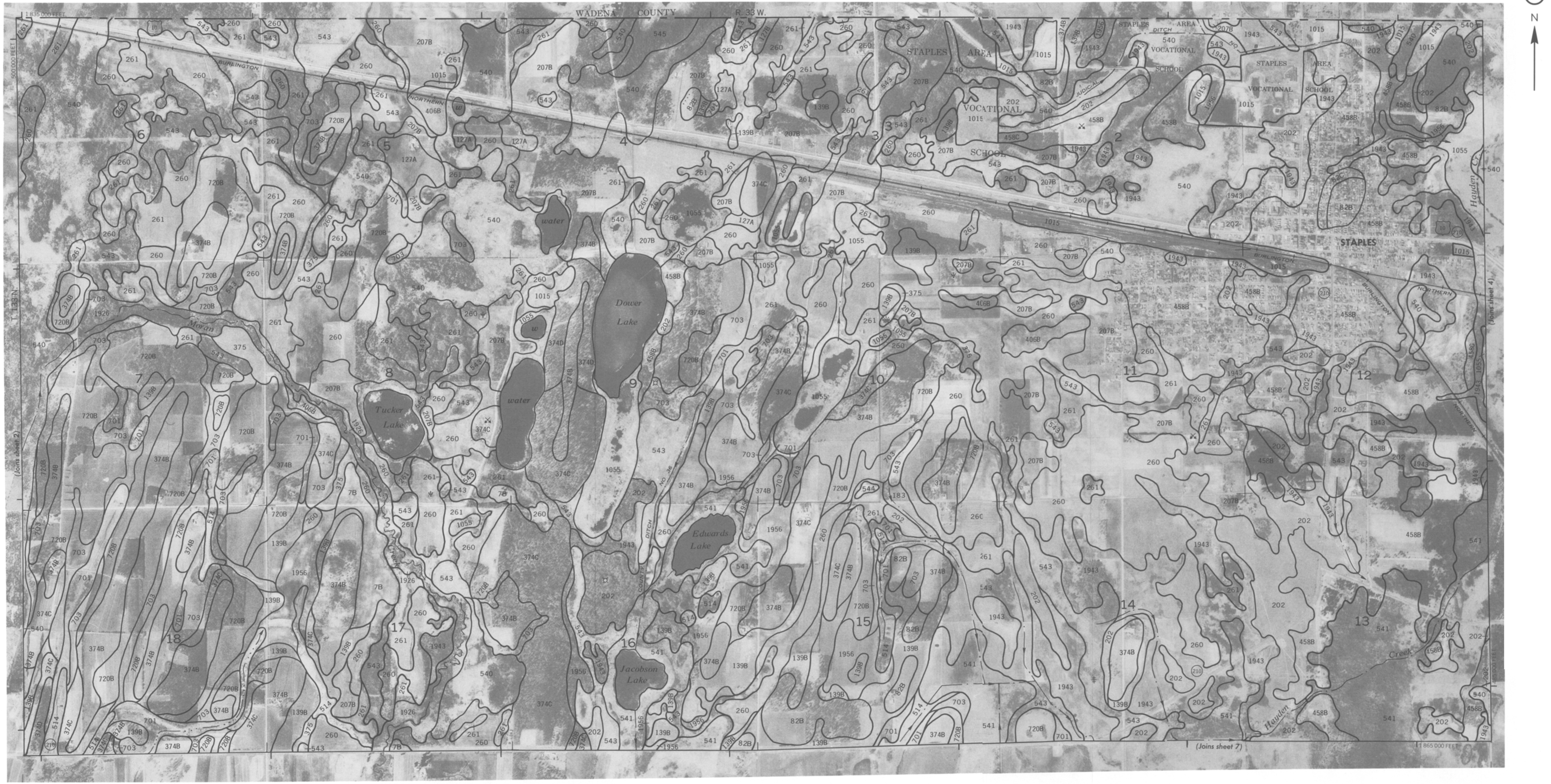
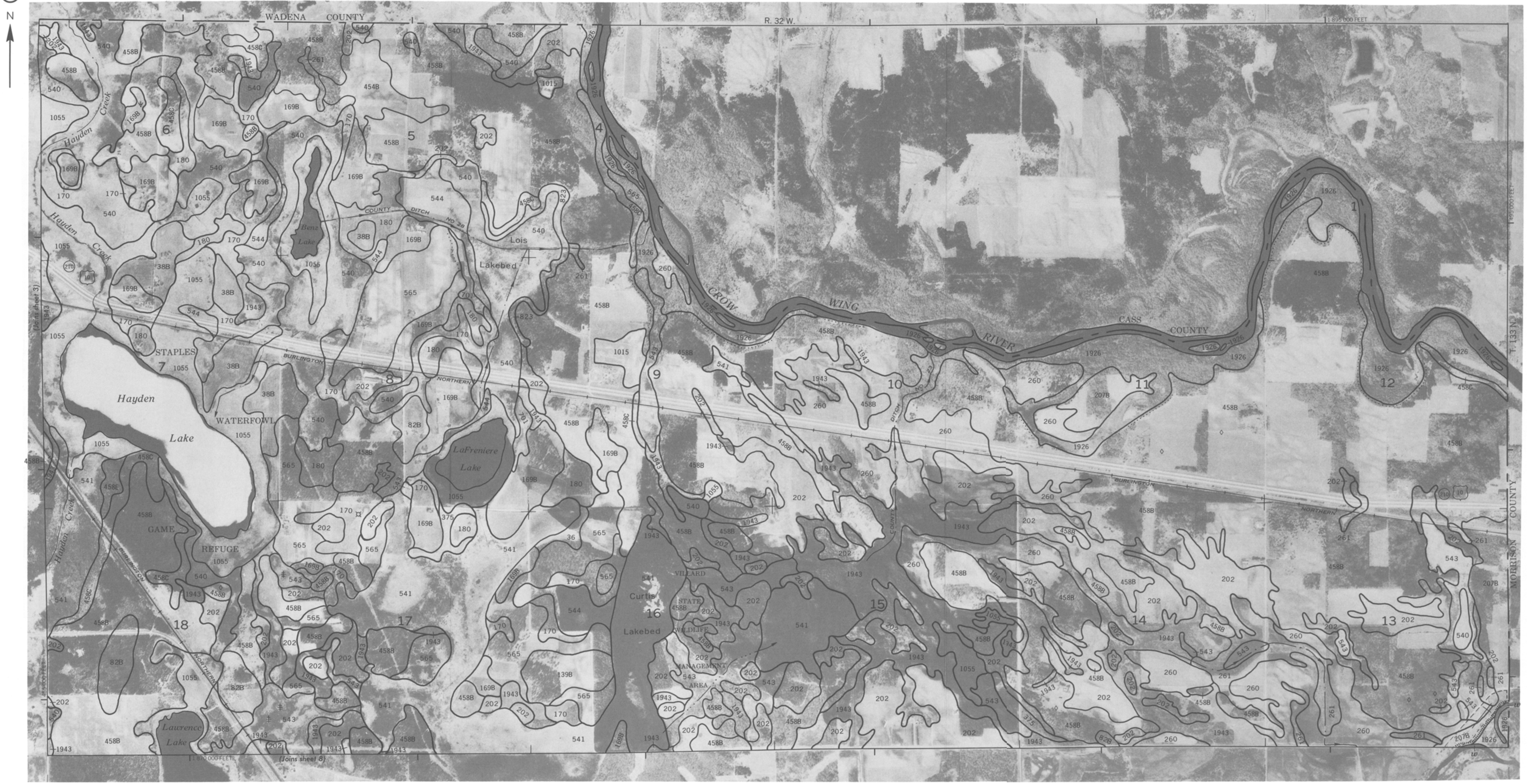
12
13
14
15
16
17
18

TODD COUNTY, MINNESOTA — SHEET NUMBER 3


③
N
WADENA COUNTY
R. 33 W.
1 835 000 FEET
500 000 FEET
T. 133 N.
1 865 000 FEET
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 7)
BURLINGTON NORTHERN
STAPLES
STAPLES AREA VOCATIONAL SCHOOL
JUDICIAL DITCH NO 2
COUNTY DITCH NO 36
Moran
Hayden Cr.
Hayden Creek
Dower Lake
Tucker Lake
Edwards Lake
Jacobson Lake
water
w
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


N
WADENA COUNTY
R. 32 W.
1 895 000 FEET
T. 133 N.
CASS COUNTY
MORRISON COUNTY
CROW WING RIVER
Hayden Creek
Benz Lake
COUNTY DITCH NO. 38
Lois Lakebed
STAPLES
Hayden Lake
WATERFOWL GAME REFUGE
BURLINGTON NORTHERN
LaFreniere Lake
Curtis Lakebed
VILLARD STATE WILDLIFE MANAGEMENT AREA
COUNTY DITCH NO. 23
Laurence Lake
1 870 000 FEET
(Joins sheet 3)
(Joins sheet 8)
210
10
1
2
3
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11
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14
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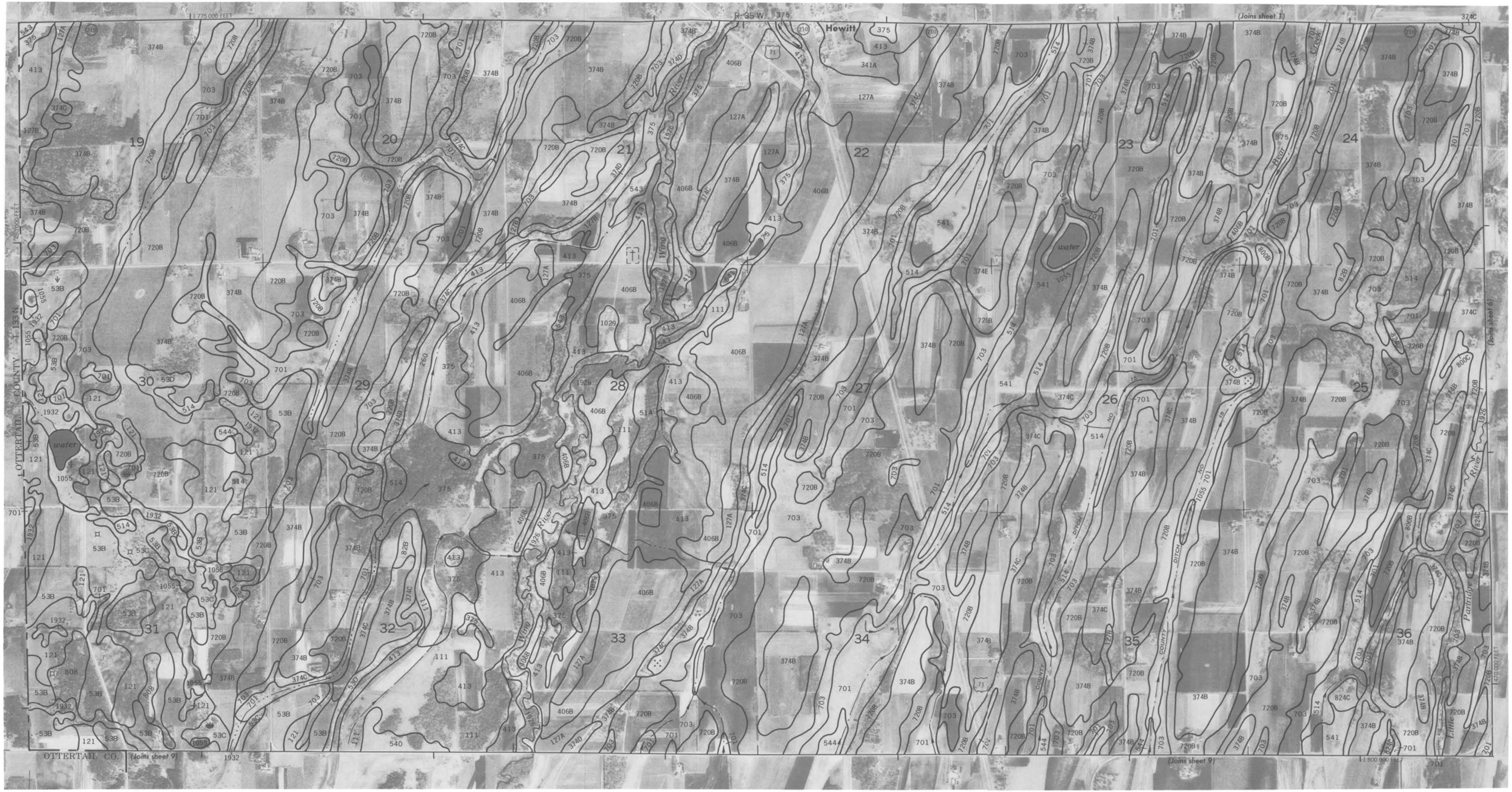
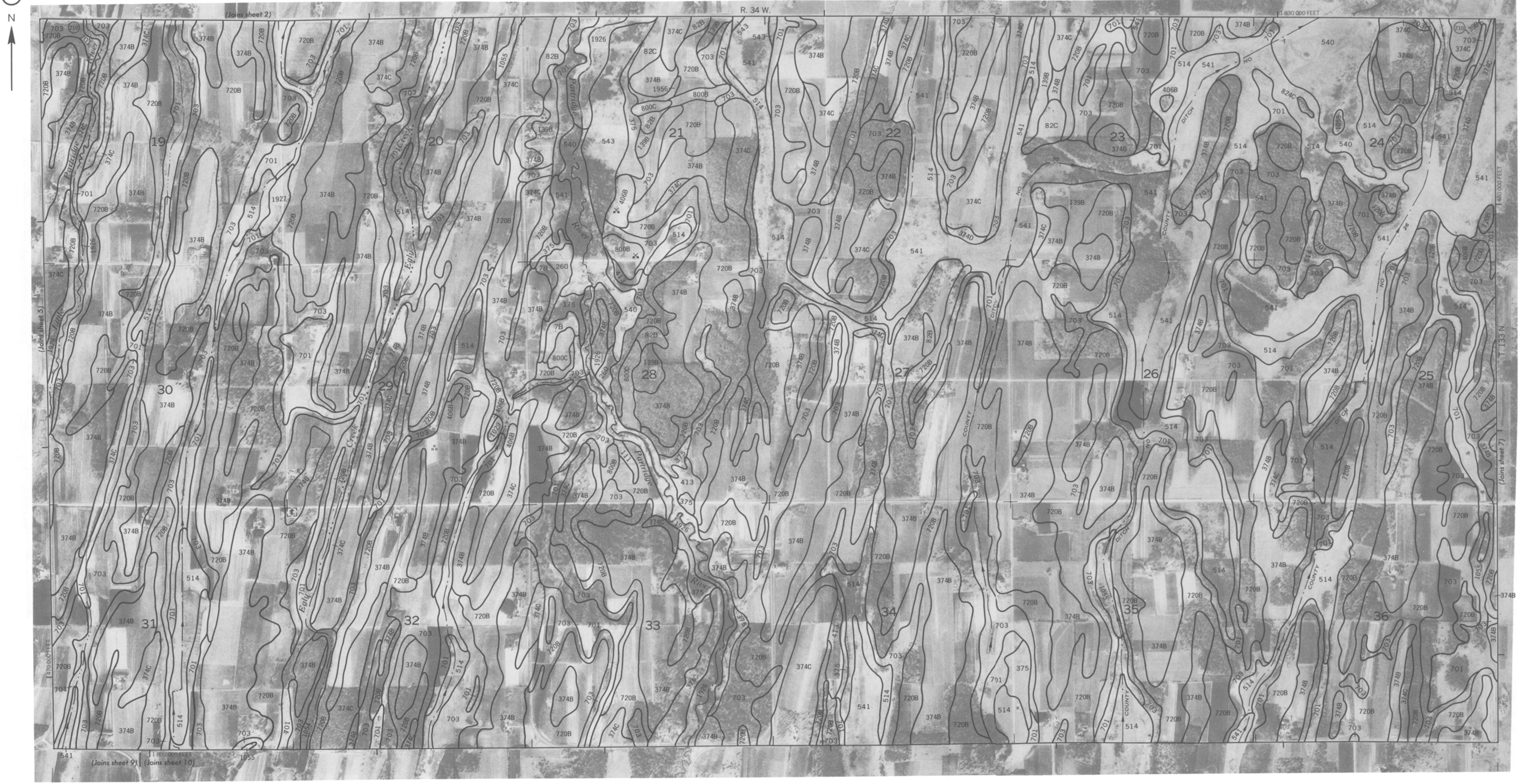
18

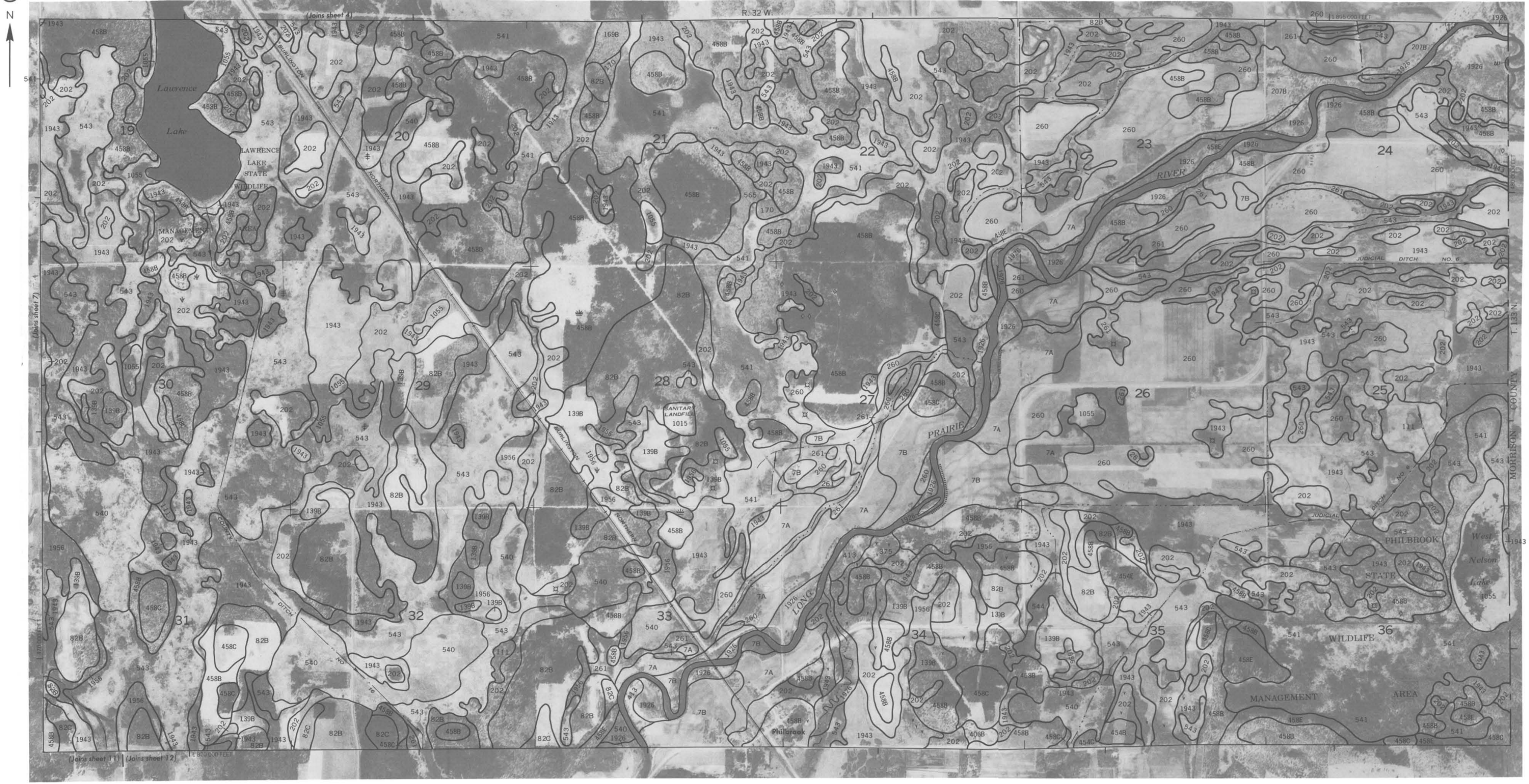
TODD COUNTY, MINNESOTA — SHEET NUMBER 5

5


N
R. 35 W.
Hewitt
(Joins sheet 1)
(Joins sheet 6)
(Joins sheet 9)
OTTERTAIL COUNTY
OTTERTAIL CO.
T. 133 N.
1 775 000 FEET
1 800 000 FEET
470 000 FEET
Wing River
Bear Creek
Little Partridge River
COUNTY DITCH NO 15
water
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36


N
(Joins sheet 2)
R. 34 W.
1 830 000 FEET
(Joins sheet 5)
(Joins sheet 7)
T. 133 N.
480 000 FEET
470 000 FEET
(Joins sheet 9)
(Joins sheet 10)
1 800 000 FEET
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
Partridge River
Little Partridge River
Eagle Creek
County Ditch No 1
County Ditch No 26
210

N
R. 33 W.
T. 133 N.
(Joins sheet 3)
(Joins sheet 6)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 11)
1 835 000 FEET
480 000 FEET
1 865 000 FEET
210
Mumm Lake
Jasmer Lake
Moran Creek
Moran Creek
County Ditch No 36
County Ditch
County Ditch No
Rice Lake
Staples
Rice Lake State Wildlife Management Area
Stony Brook
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36


N
(Joins sheet 4)
R. 32 W.
1 890 000 FEET
(Joins sheet 7)
T. 133 N.
(Joins sheet 11)
(Joins sheet 12)
1 820 000 FEET
470 000 FEET
Laurence Lake
LAWRENCE LAKE STATE WILDLIFE MANAGEMENT AREA
BURLINGTON NORTHERN
COUNTY DITCH NO 16
SANITARY LANDFILL
LONG PRAIRIE RIVER
JUDICIAL DITCH NO. 6
JUDICIAL DITCH NO. 6
PHILBROOK STATE WILDLIFE MANAGEMENT AREA
West Nelson Lake
Philbrook
MORRISON COUNTY
19
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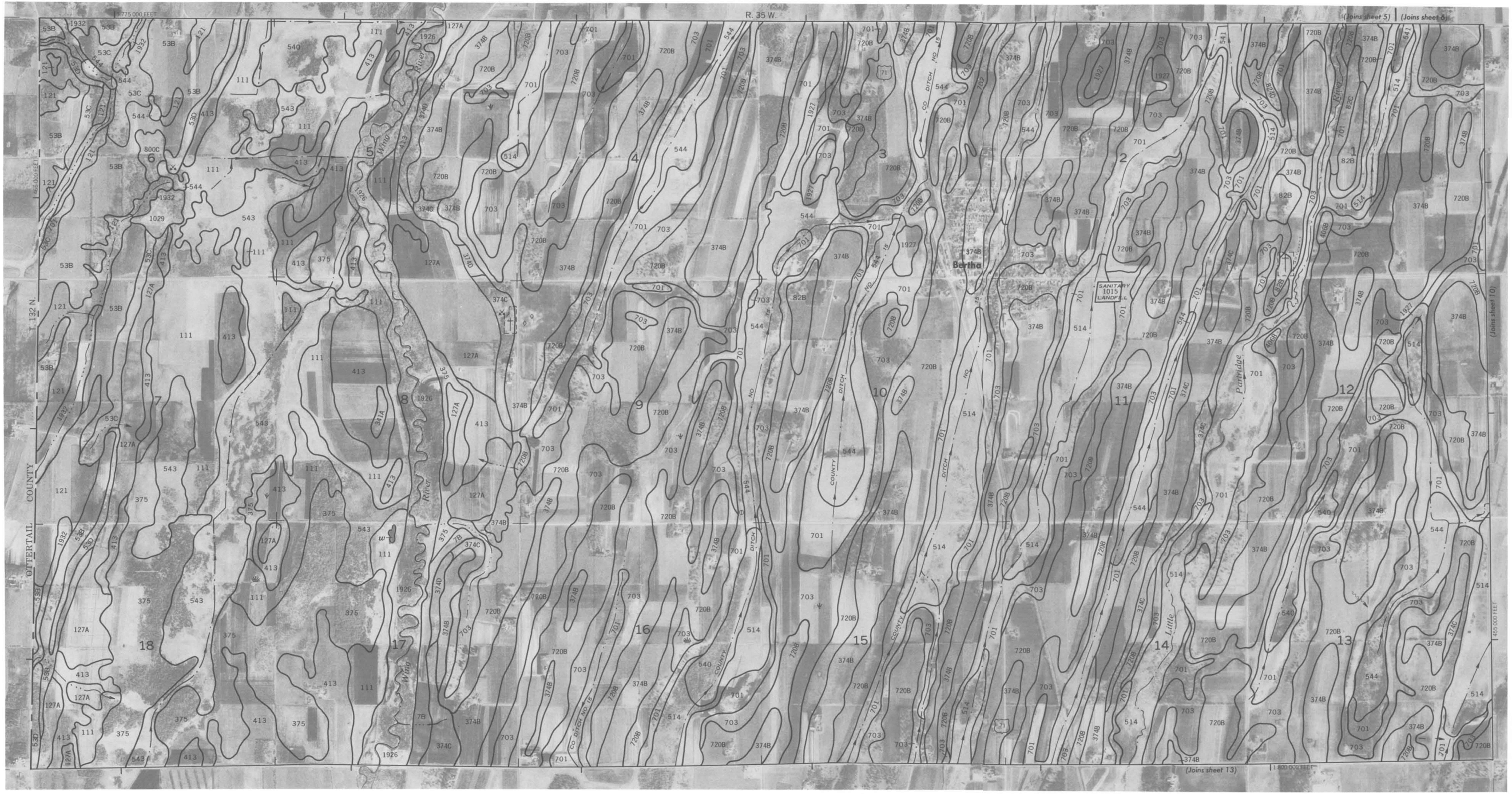
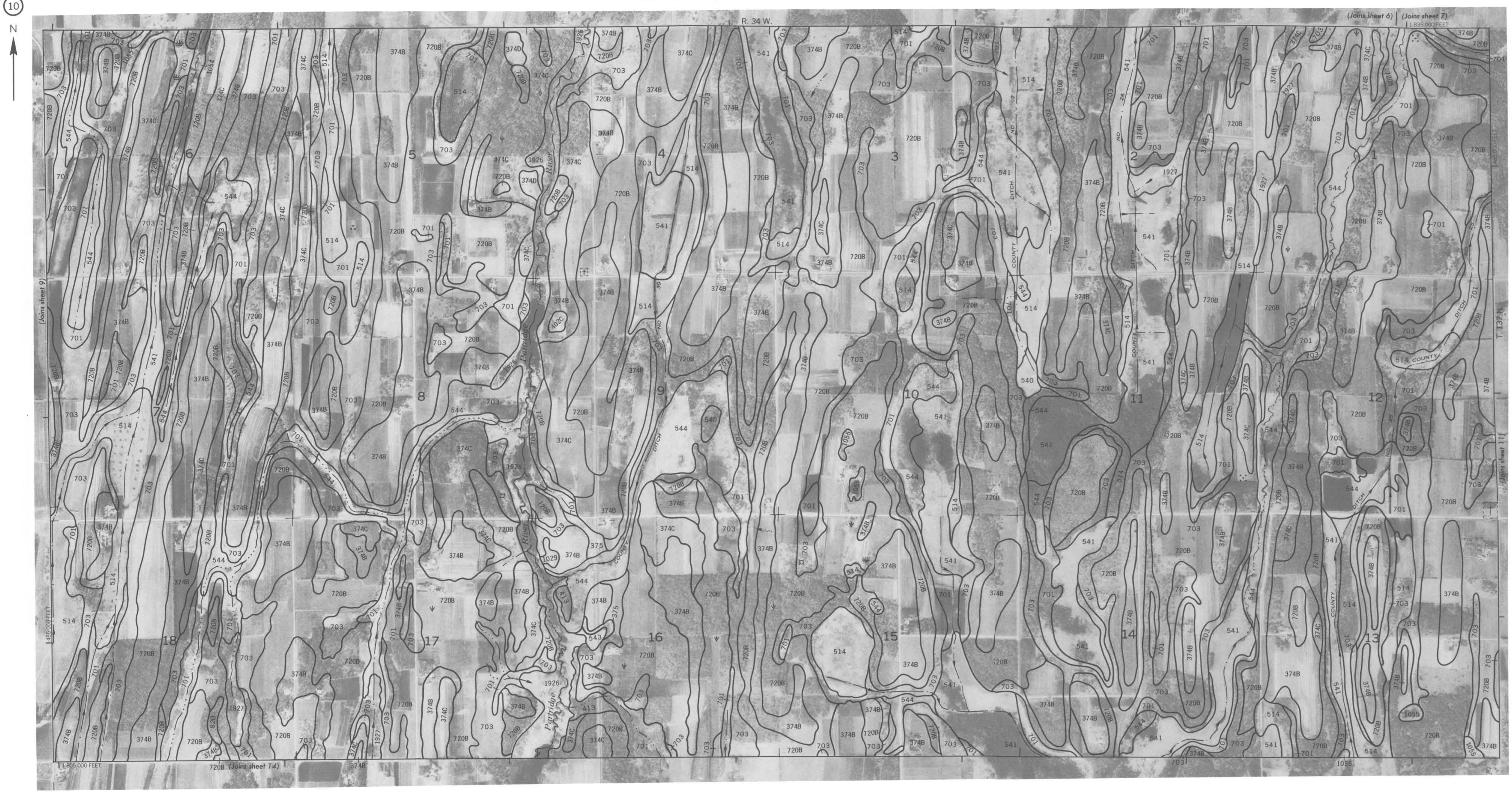
36

TODD COUNTY, MINNESOTA — SHEET NUMBER 9


9
N
1 775 000 FEET
R. 35 W.
(Joins sheet 5)
(Joins sheet 6)
(Joins sheet 10)
(Joins sheet 13)
1 800 000 FEET
465 000 FEET
455 000 FEET
T. 132 N.
OTTERTAIL COUNTY
Bertha
SANITARY 1015 LANDFILL
Wing River
Partridge River
Little
CO DITCH NO 15
COUNTY DITCH NO 15
71
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
53B
53C
53D
7B
82B
82C
111
121
127A
341A
374B
374C
374D
375
406B
413
514
540
543
544
701
703
720B
800C
1029
1926
1927
1932


10
N
R. 34 W.
(Joins sheet 6)
(Joins sheet 7)
1 835 000 FEET
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 14)
T. 132 N.
485 000 FEET
1 805 000 FEET
1
2
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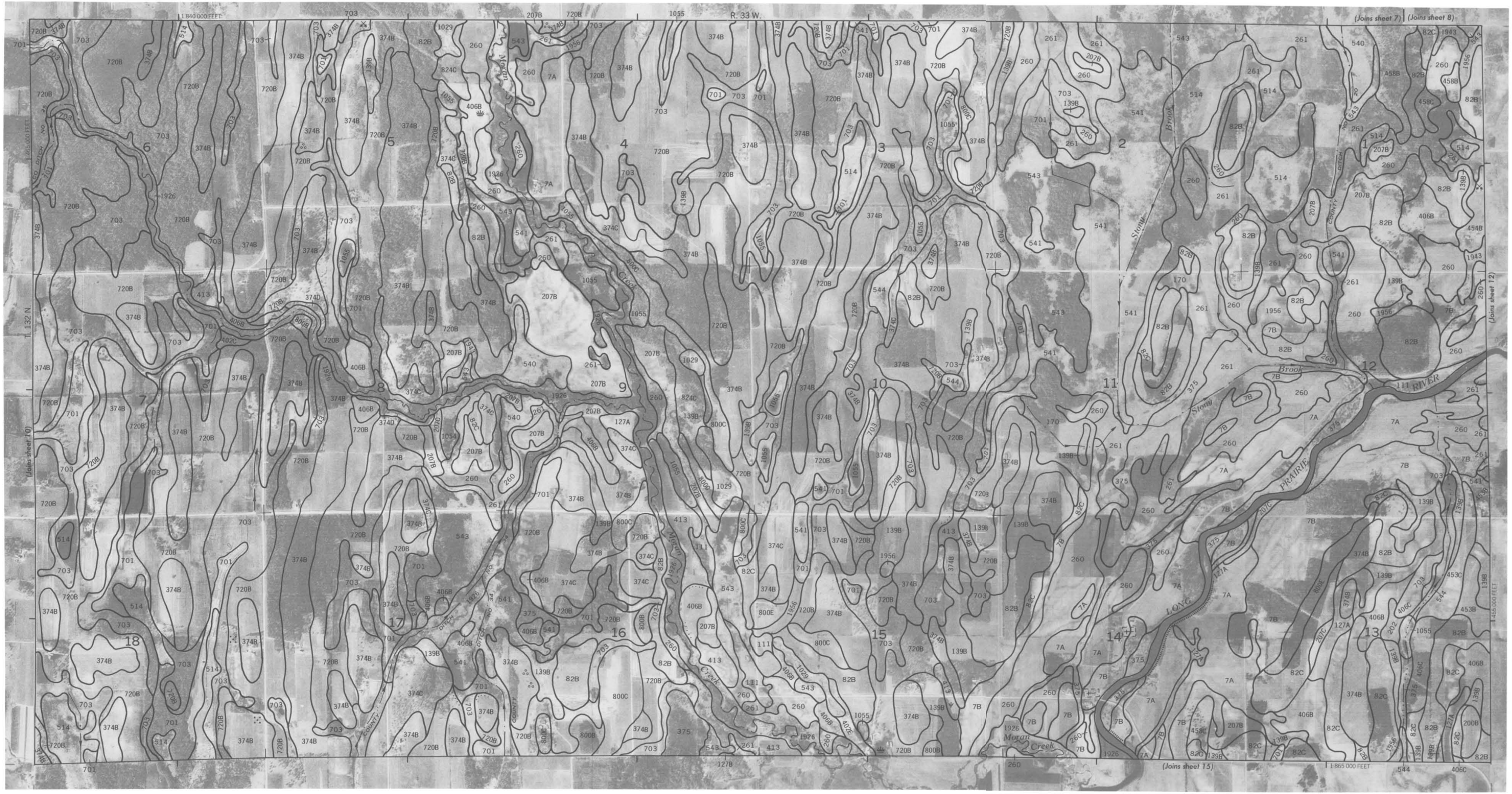
16
17
18
Partridge River
COUNTY DITCH NO 39
COUNTY DITCH NO 26
COUNTY DITCH NO 25
374B
374C
374D
375
402C
413
514
540
541
543
544
701
703
720B
828
1029
1054
1055
1926
1927


N
1 840 000 FEET
R. 33 W.
T. 132 N.
1 865 000 FEET
1 465 000 FEET
(Joins sheet 7)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 15)
Moran Creek
Stony Brook
LONG PRAIRIE RIVER
County Ditch No. 34
County Ditch No. 25
1
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3
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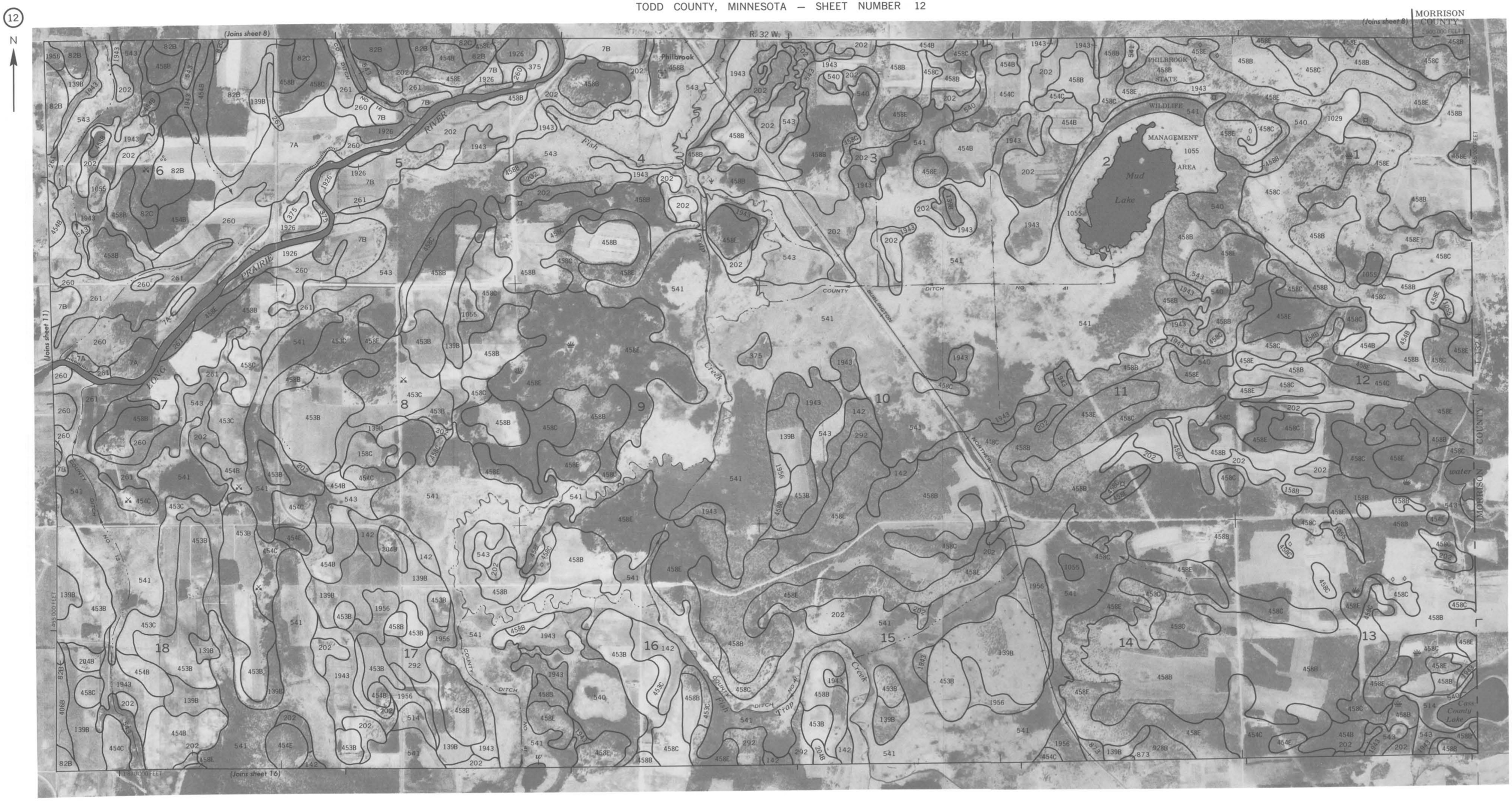
18

TODD COUNTY, MINNESOTA — SHEET NUMBER 12


12
N
(Joins sheet 8)
MORRISON COUNTY
R. 32 W.
Philbrook
PHILBROOK STATE WILDLIFE MANAGEMENT AREA
Mud Lake
LONG PRAIRIE RIVER
Fish Trap Creek
COUNTY DITCH NO 41
BURLINGTON NORTHERN
COUNTY DITCH NO 13
COUNTY DITCH NO 4
(Joins sheet 11)
(Joins sheet 16)
T. 132 N.
MORRISON COUNTY
water
Cass County Lake
1
2
3
4
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8
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12
13
14
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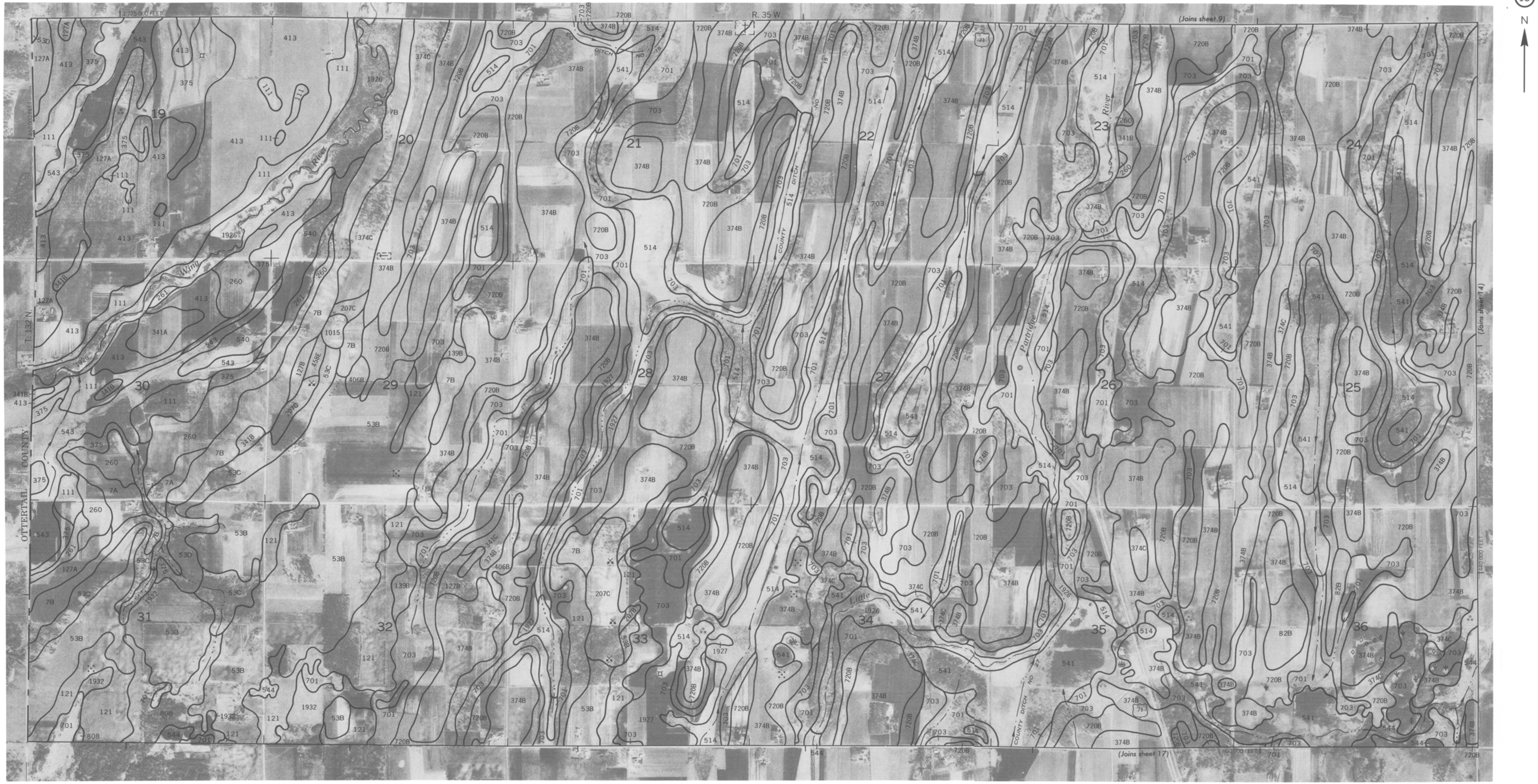
16
17
18

TODD COUNTY, MINNESOTA — SHEET NUMBER 13


13
N
R. 35 W.
(Joins sheet 9)
(Joins sheet 14)
(Joins sheet 17)
T. 132 N.
OTTERTAIL COUNTY
1 375 000 FEET
440 000 FEET
400 000 FEET
Wing River
Partridge River
Little
COUNTY DITCH NO. 15
COUNTY DITCH NO. 27
DITCH NO. 15
19
20
21
22
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24
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26
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32
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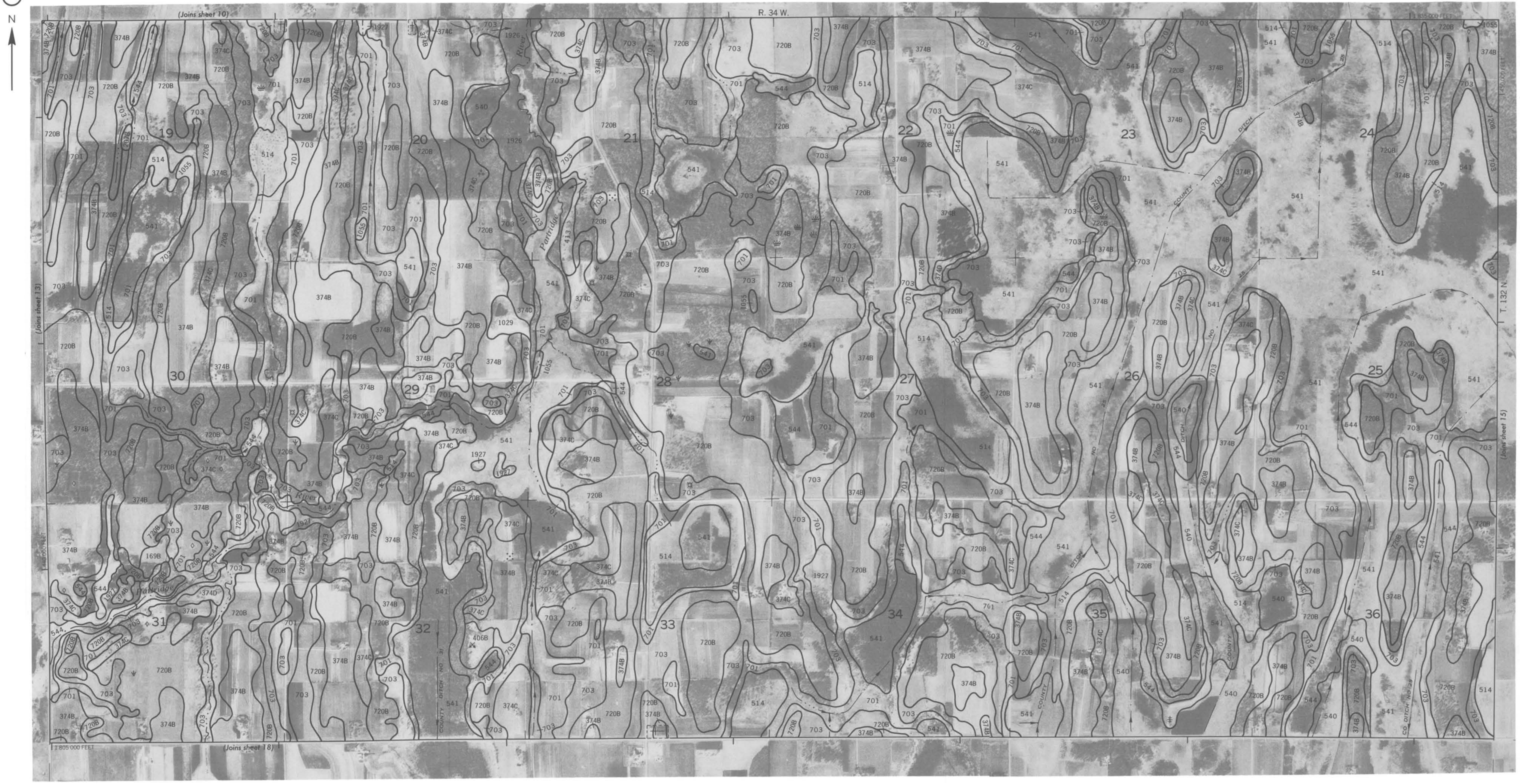
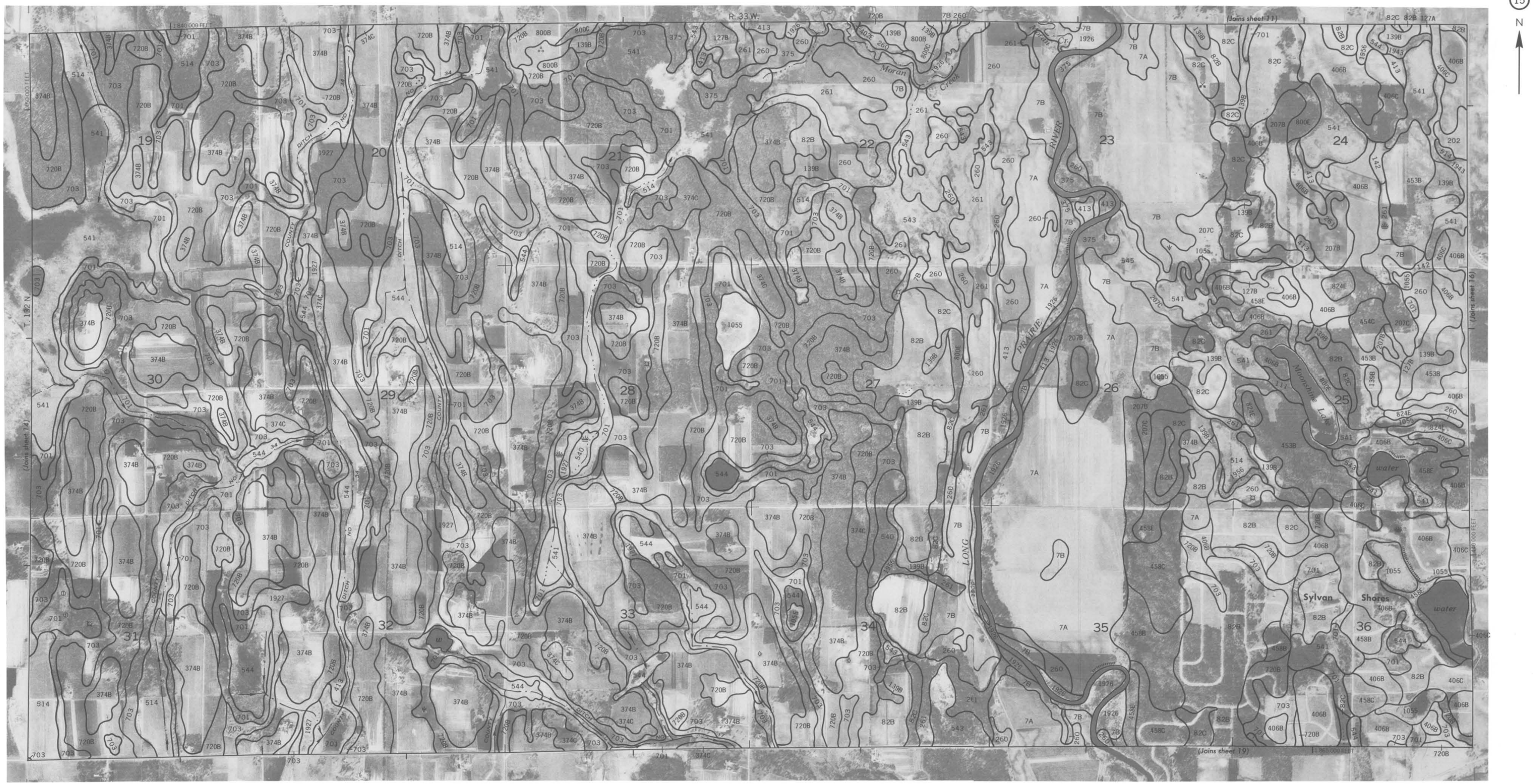
36

TODD COUNTY, MINNESOTA — SHEET NUMBER 14

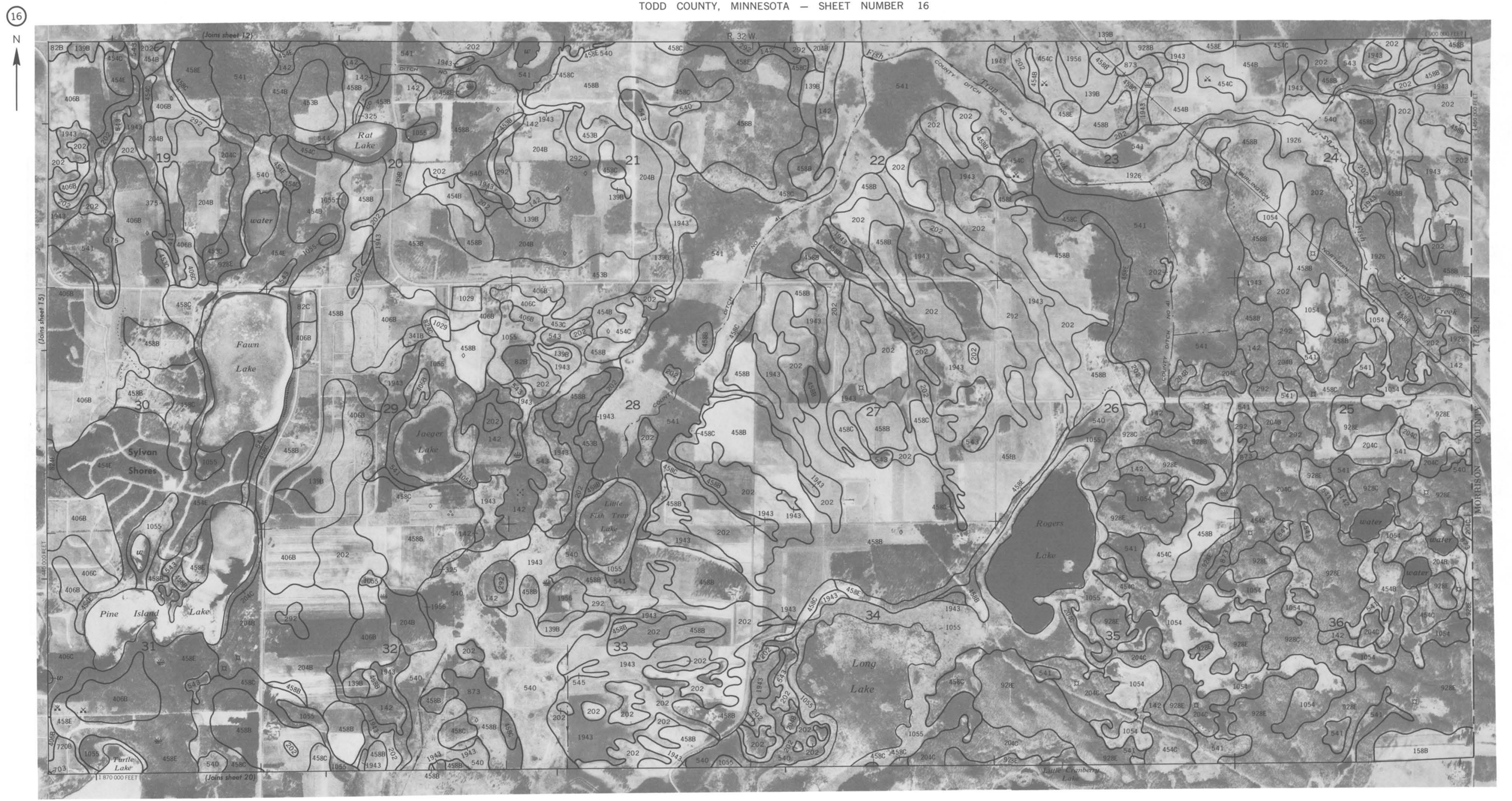

N
(Joins sheet 10)
R. 34 W.
1 835 000 FEET
(Joins sheet 13)
(Joins sheet 15)
T. 132 N.
(Joins sheet 18)
1 805 000 FEET
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
Partridge
River
COUNTY DITCH NO. 25
COUNTY DITCH NO. 31
CO. DITCH NO. 28

TODD COUNTY, MINNESOTA — SHEET NUMBER 15

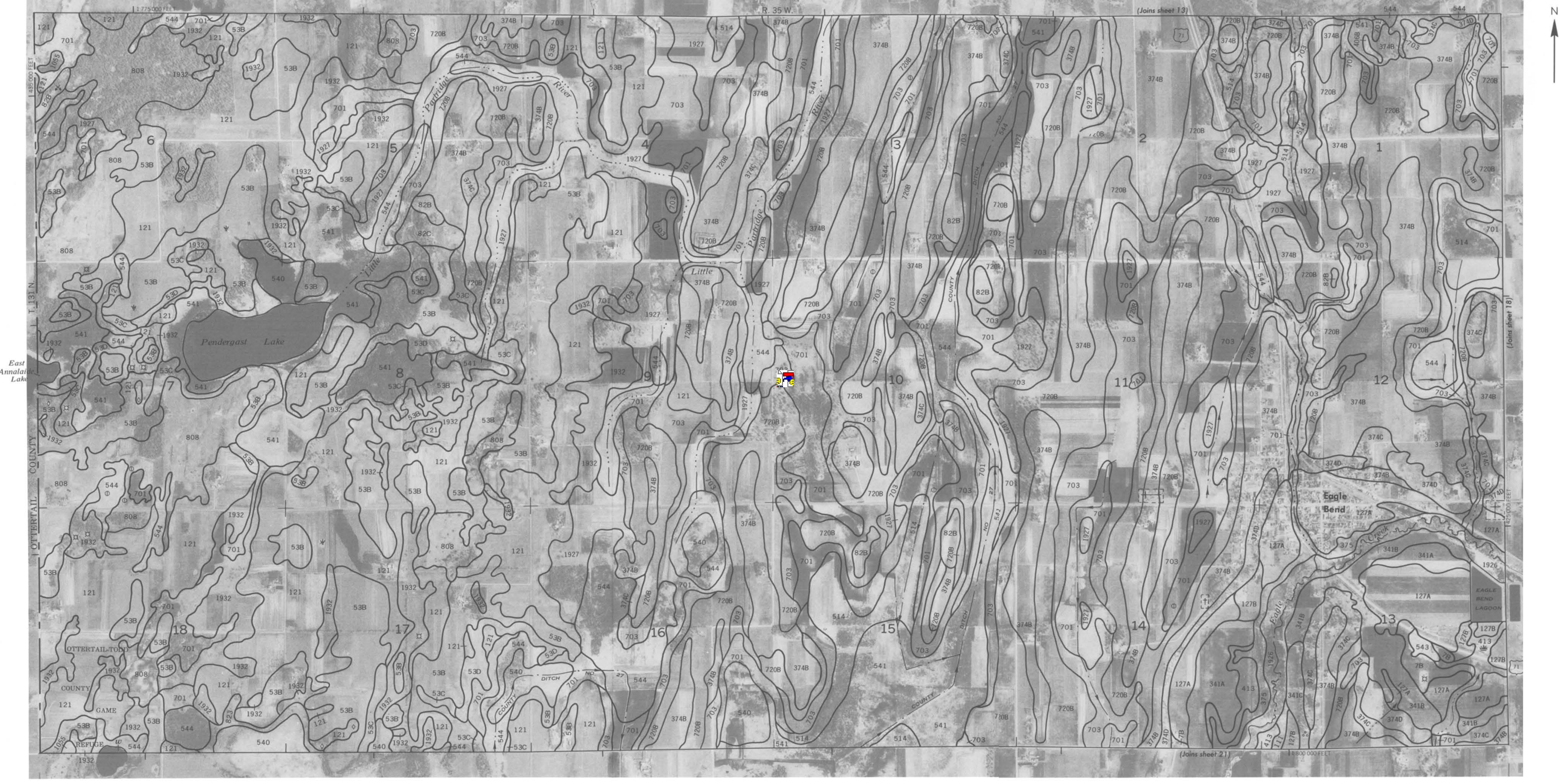

15
N
R. 33 W.
T. 132 N.
1 840 000 FEET
1 850 000 FEET
(Joins sheet 11)
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 19)
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
LONG PRAIRIE RIVER
Moran Creek
Moonshine Lake
Sylvan Shores
water
COUNTY DITCH NO 34
COUNTY DITCH NO 413
COUNTY DITCH NO 544
374B
720B
703
701
541
514
1927
82C
82B
7A
7B
260
261
406B
1055

⑯

TODD COUNTY, MINNESOTA — SHEET NUMBER 16


N
(Joins sheet 12)
R. 32 W.
1 900 000 FEET
(Joins sheet 15)
140 000 FEET
T. 132 N.
MORRISON COUNTY
(Joins sheet 20)
1 870 000 FEET
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
Rat Lake
Fawn Lake
Sylvan Shores
Jaeger Lake
Pine Island Lake
Turtle Lake
Little Fish Trap Lake
Rogers Lake
Long Lake
Little Cranberry Lake
Fish Trap Creek
COUNTY DITCH NO 41
COUNTY DITCH NO 41
BURLINGTON NORTHERN
DITCH NO 41
water

TODD COUNTY, MINNESOTA — SHEET NUMBER 17


N
(Joins sheet 13)
R. 35 W.
1 775 000 FEET
435 000 FEET
T. 131 N.
OTTERTAIL COUNTY
East Annalaide Lake
Pendergast Lake
Little Partridge River
Little Partridge
COUNTY DITCH NO. 27
COUNTY
Eagle Bend
Eagle Creek
EAGLE BEND LAGOON
OTTERTAIL-TODD COUNTY GAME REFUGE
(Joins sheet 18)
425 000 FEET
(Joins sheet 21)
1 800 000 FEET
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
121
701
808
1932
53B
53C
82B
82C
121
127A
127B
341A
341B
341C
374B
374C
374D
375
413
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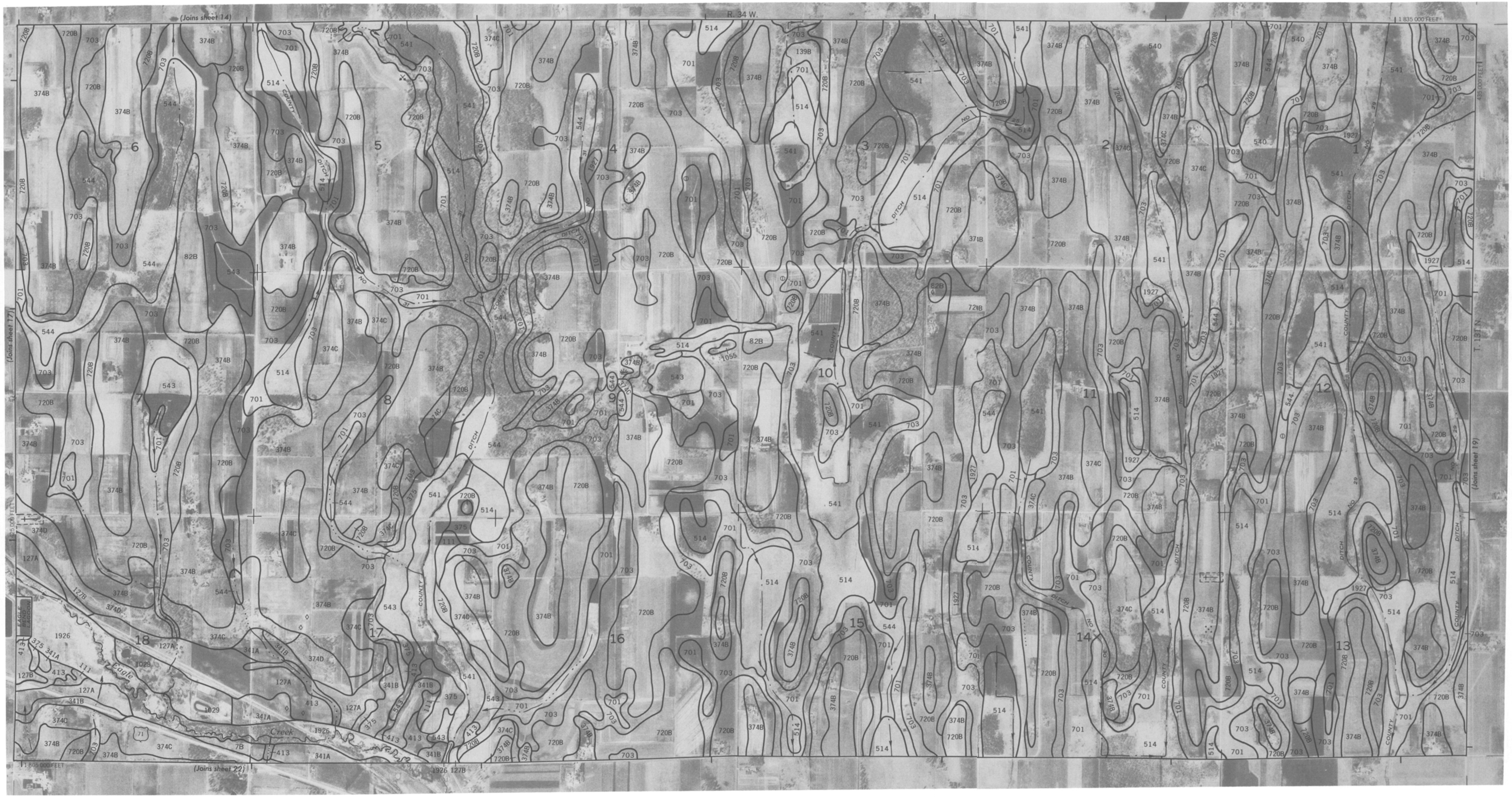
541
543
544
703
720B
1055
1926
1927
7B

TODD COUNTY, MINNESOTA — SHEET NUMBER 18


N
(Joins sheet 14)
R. 34 W.
1 835 000 FEET
(Joins sheet 17)
(Joins sheet 19)
T. 131 N.
(Joins sheet 22)
1 805 000 FEET
425 000 FEET
EAGLE LAGOON
Eagle Creek
71
COUNTY DITCH
1
2
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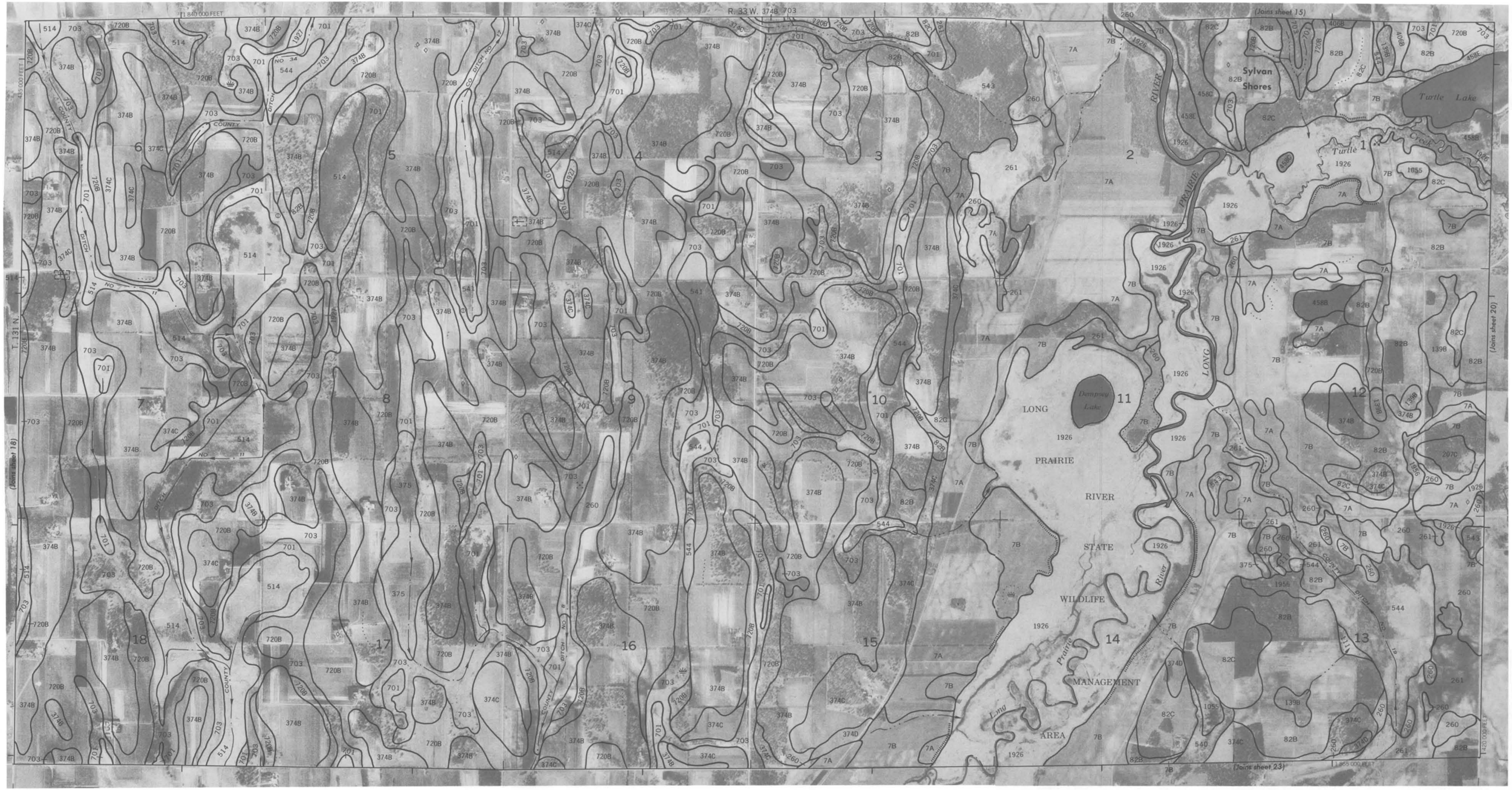
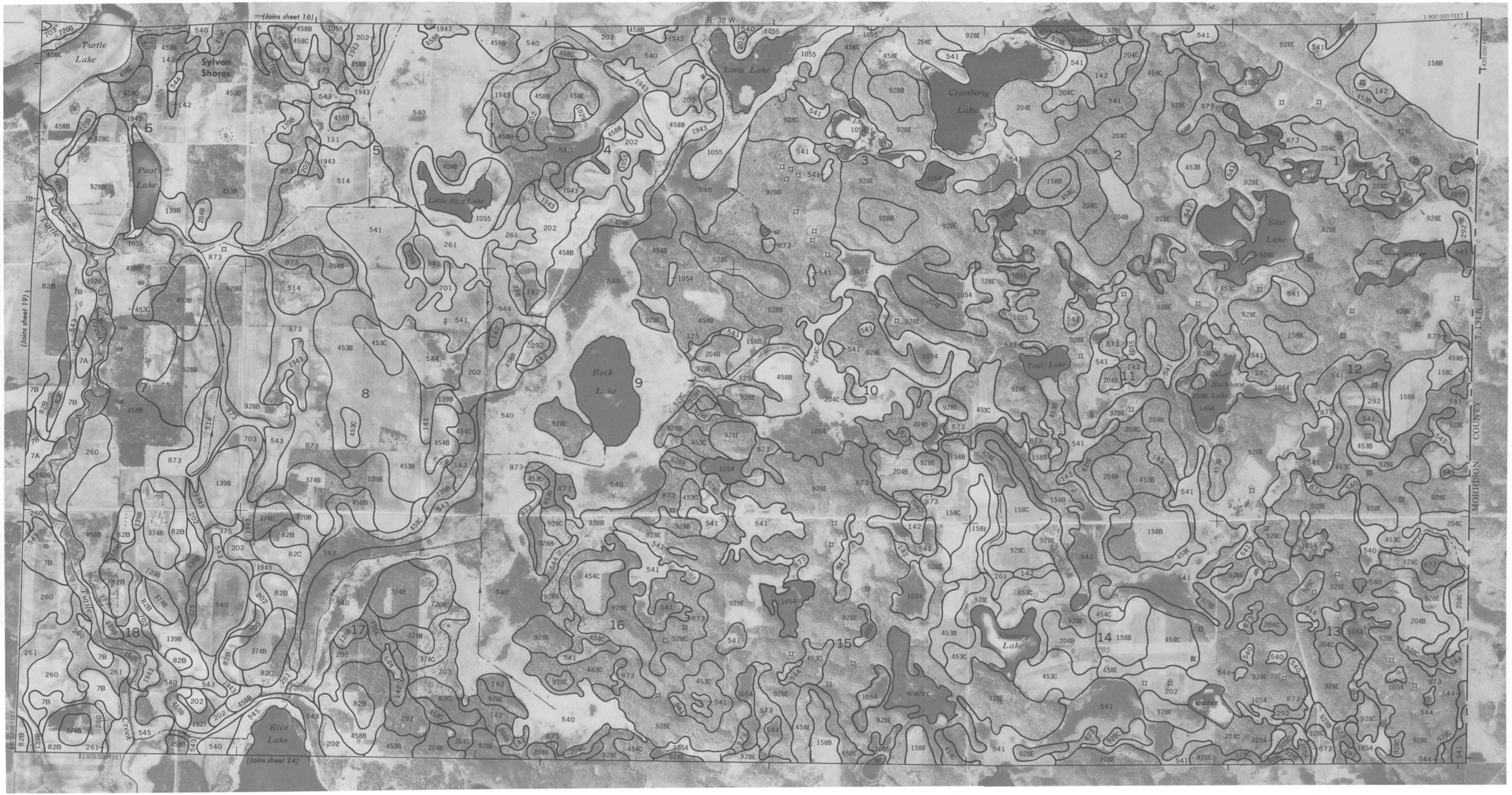
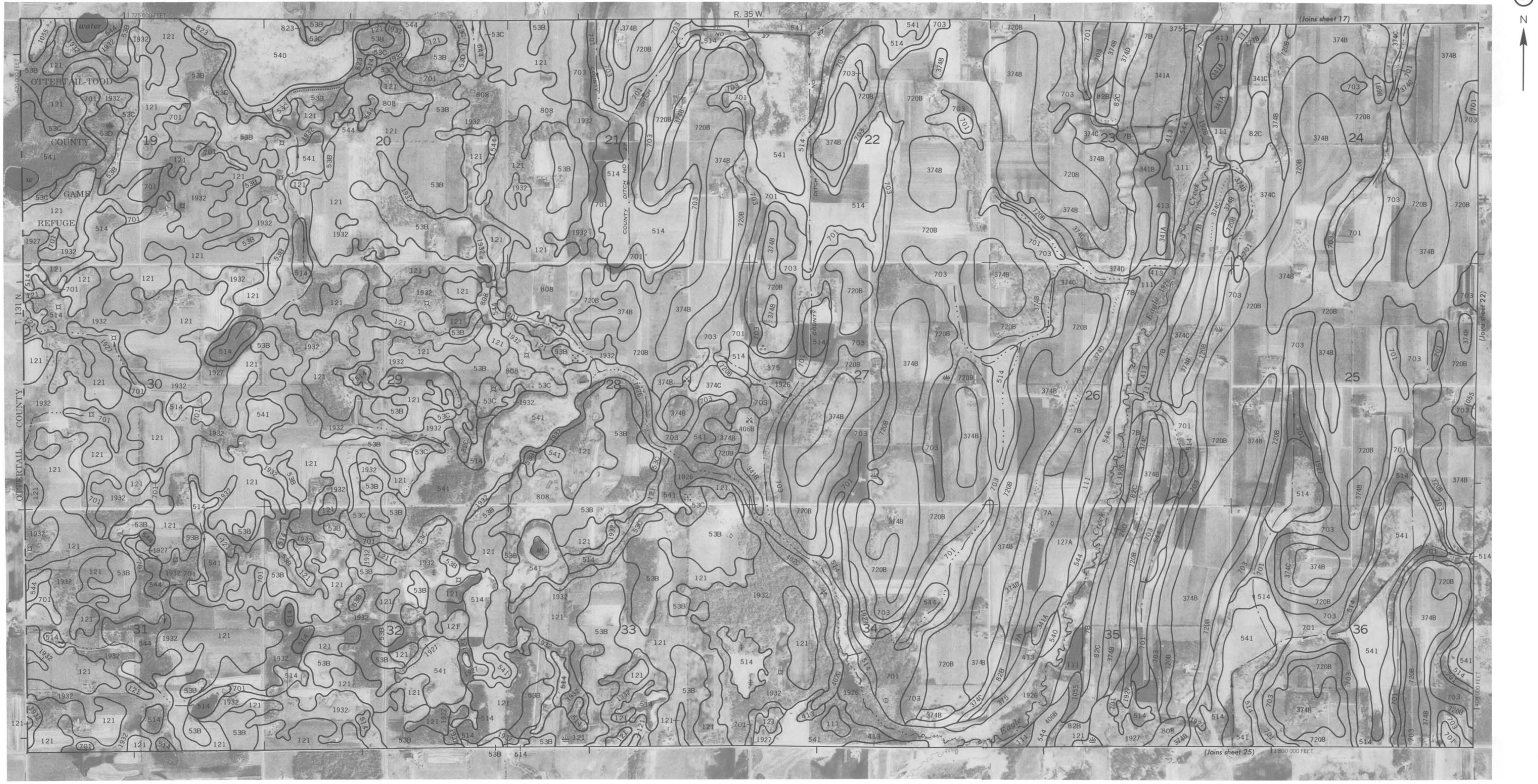
18

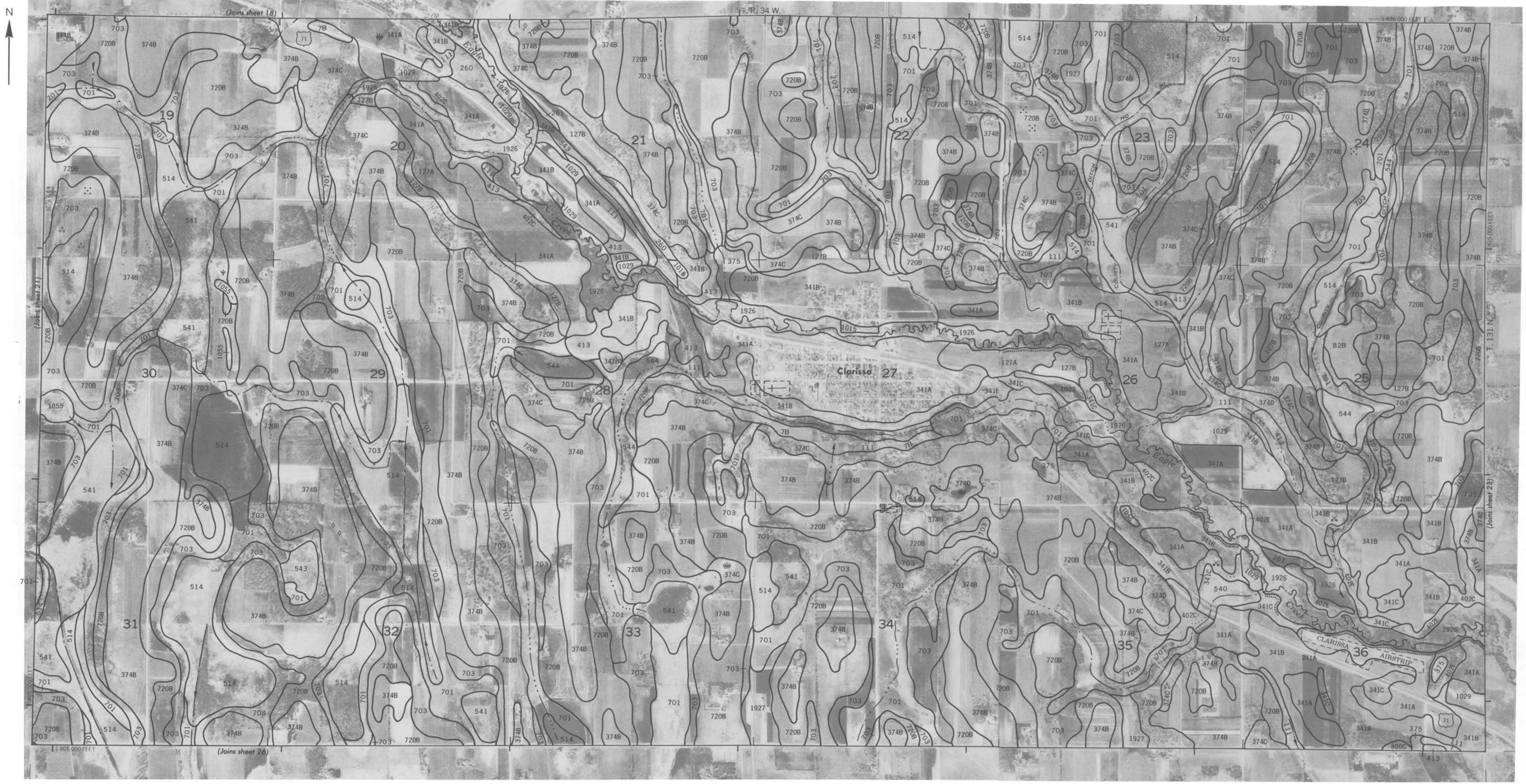
TODD COUNTY, MINNESOTA — SHEET NUMBER 19

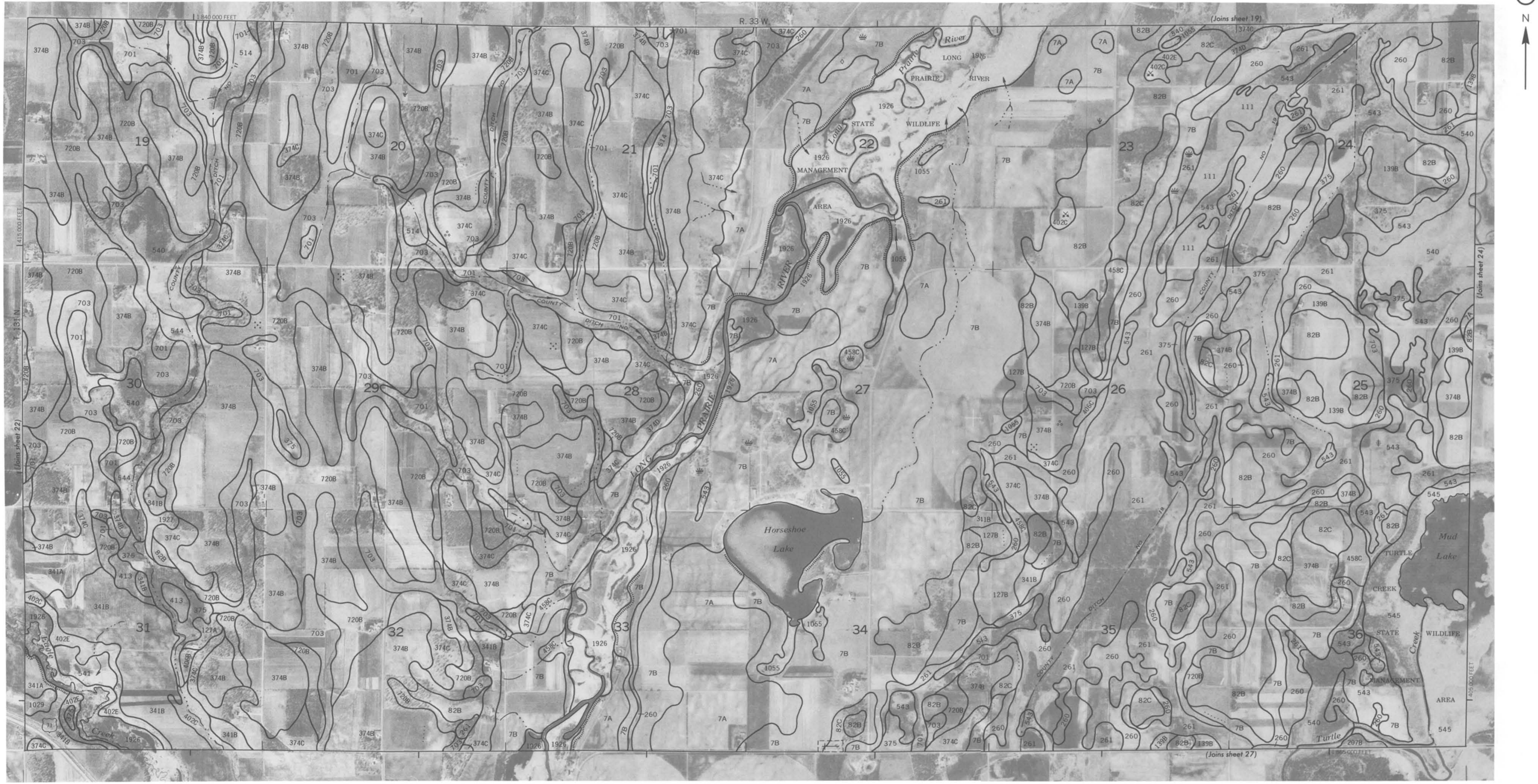

N
R. 33 W.
1 840 000 FEET
435 000 FEET
T. 131 N.
(Joins sheet 15)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 23)
1 865 000 FEET
420 000 FEET
Sylvan Shores
Turtle Lake
Turtle Creek
PRAIRIE RIVER
LONG PRAIRIE
Long Prairie River
Dempsey Lake
LONG PRAIRIE RIVER STATE WILDLIFE MANAGEMENT AREA
COUNTY
DITCH NO 11
DITCH NO 34
CO DITCH NO 17
DITCH NO 8
COUNTY DITCH NO 19
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
7A
7B
82B
82C
139B
207C
260
261
374B
374C
374D
375
406B
458B
458C
514
540
541
543
544
701
703
720B
1055
1926
1956

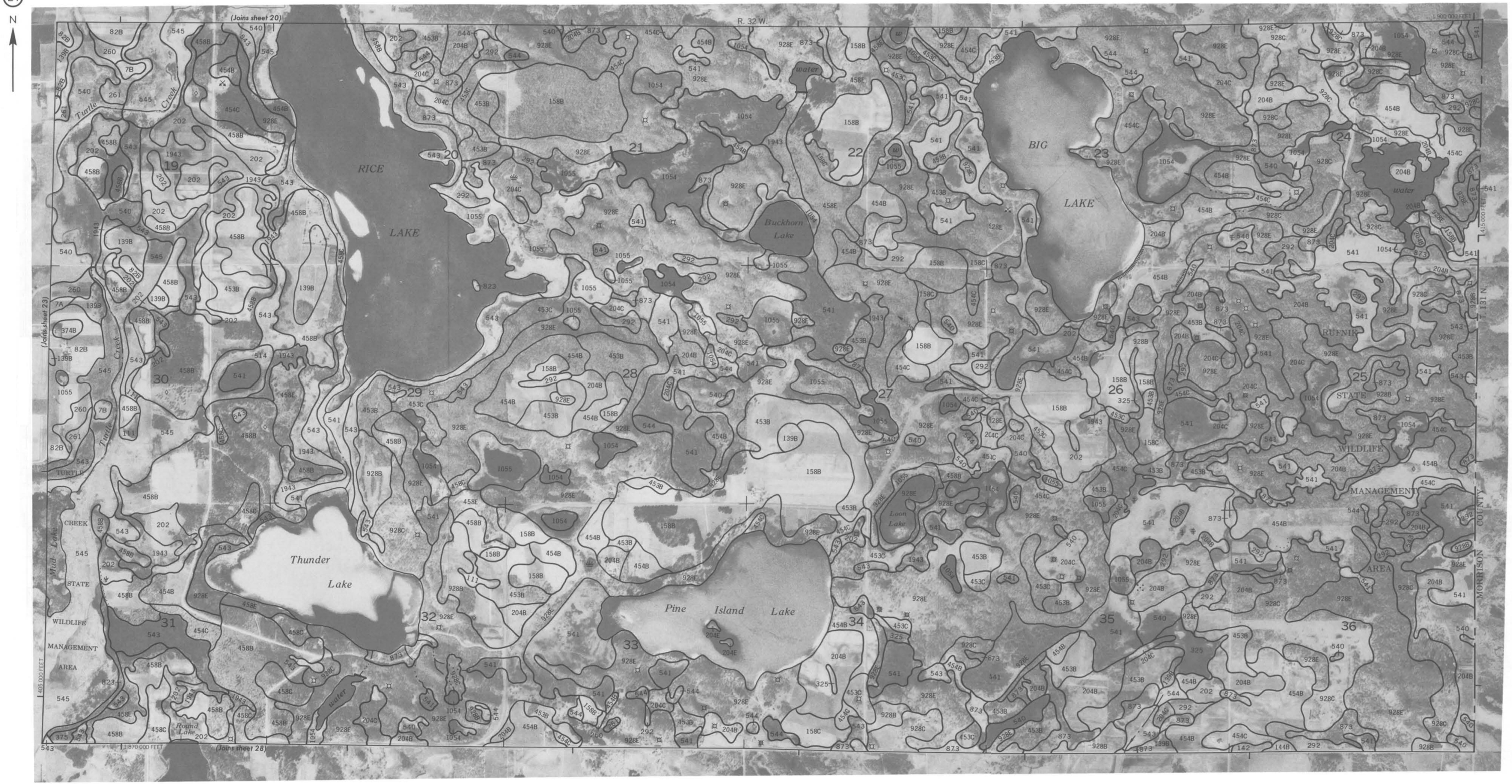
TODD COUNTY, MINNESOTA — SHEET NUMBER 20


N
(Joins sheet 16)
R. 32 W.
1 900 000 FEET
435 000 FEET
T. 131 N.
MORRISON COUNTY
(Joins sheet 19)
(Joins sheet 24)
1 870 000 FEET
Turtle Lake
Sylvan Shores
Peat Lake
Turtle Creek
Little Rice Lake
Long Lake
Cranberry Lake
Little Cranberry Lake
Star Lake
Beck Lake
Teal Lake
North Buckhorn Lake
Stumpy Lake
Rice Lake
water
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

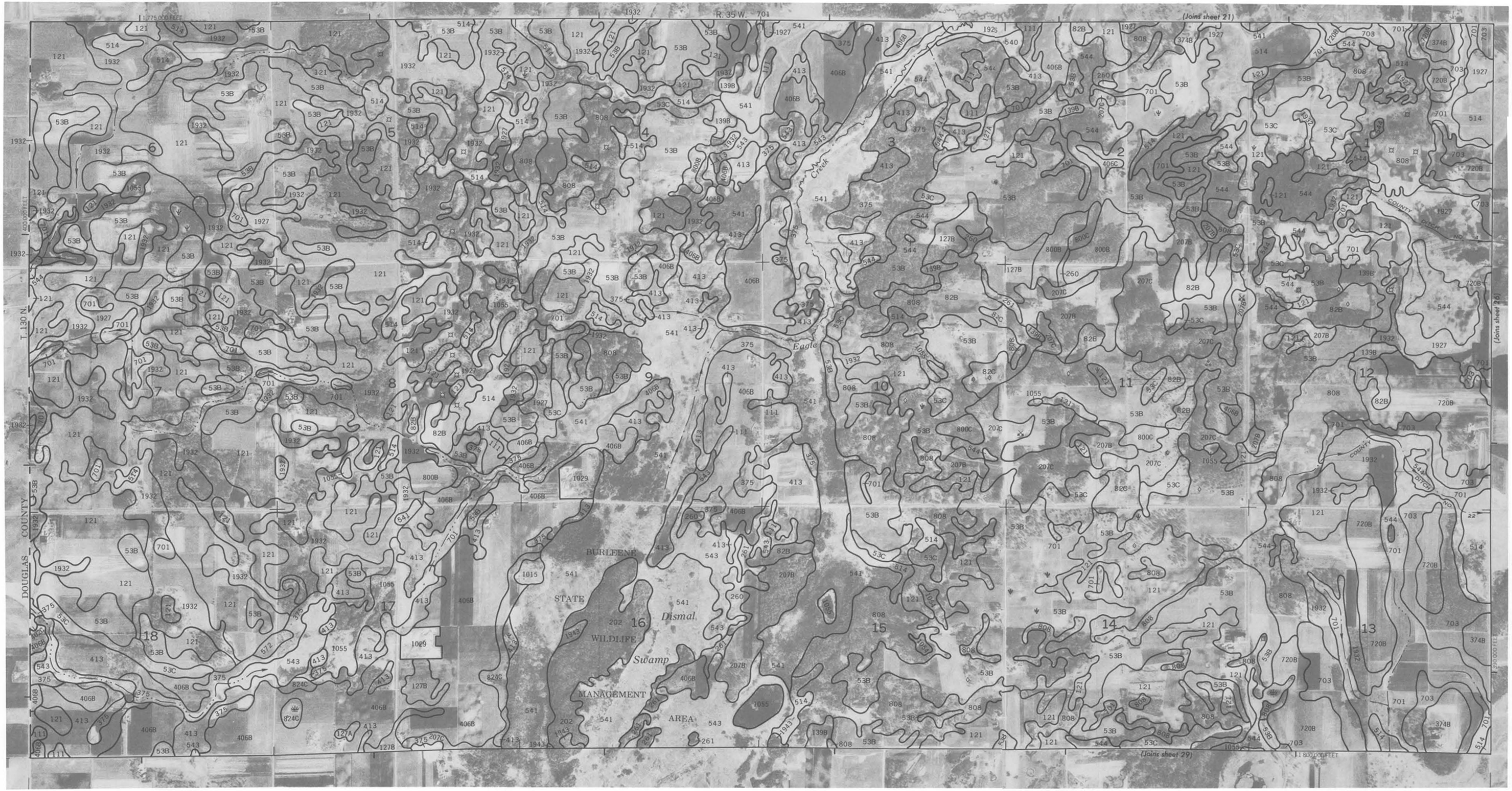

N
R. 35 W.
(Joins sheet 17)
(Joins sheet 22)
(Joins sheet 25)
T. 131 N.
1 775 000 FEET
1 800 000 FEET
420 000 FEET
405 000 FEET
OTTERTAIL-TODD COUNTY GAME REFUGE
OTTERTAIL COUNTY
water
COUNTY DITCH NO 27
COUNTY DITCH NO
Eagle Creek
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36


N
(Joins sheet 18)
R. 34 W.
1 835 000 FEET
(Joins sheet 21)
(Joins sheet 23)
T. 131 N.
415 000 FEET
405 000 FEET
1 805 000 FEET
(Joins sheet 26)
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
Clarissa
Eagle Creek
CLARISSA AIRSTRIP
COUNTY DITCH NO 30
COUNTY DITCH NO 29
71


N
(Joins sheet 19)
(Joins sheet 24)
(Joins sheet 27)
(Joins sheet 22)
R. 33 W.
T. 131 N.
1 840 000 FEET
1 865 000 FEET
415 000 FEET
405 000 FEET
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
Long Prairie River
LONG PRAIRIE RIVER
LONG PRAIRIE STATE WILDLIFE MANAGEMENT AREA
Horseshoe Lake
Mud Lake
TURTLE CREEK STATE WILDLIFE MANAGEMENT AREA
Turtle Creek
Eagle Creek
COUNTY DITCH NO 701
COUNTY DITCH NO 8
COUNTY DITCH NO 18
COUNTY DITCH NO 19
71
374B
374C
720B
703
701
514
540
544
7A
7B
1926
1055
82B
82C
260
261
543
111
139B
375
402C
402E
458C
127B
341B
341A
413
1927
1029
545

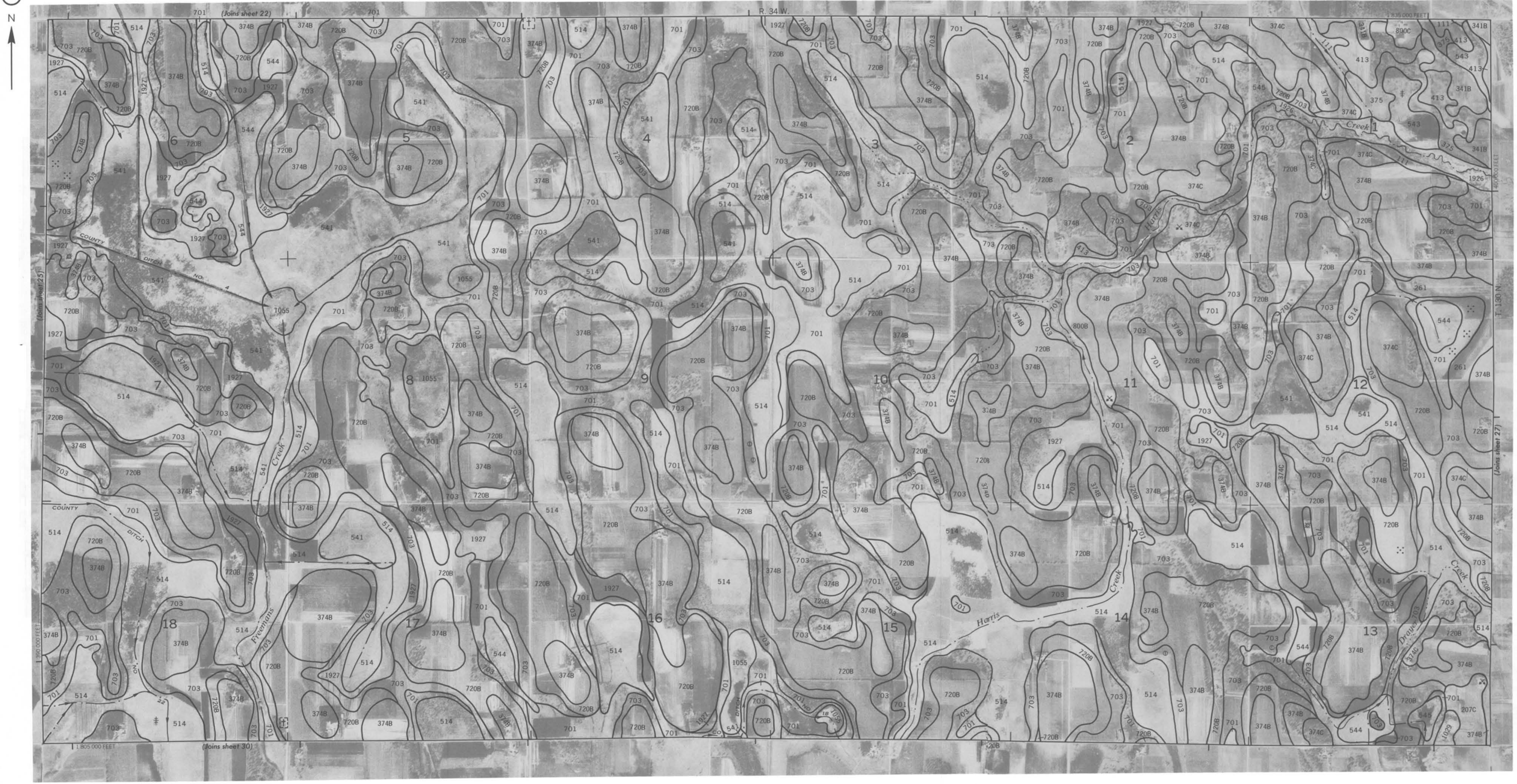

N
(Joins sheet 20)
R. 32 W.
1 900 000 FEET
RICE LAKE
BIG LAKE
Buckhorn Lake
Turtle Creek
Turtle Creek
water
water
water
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
(Joins sheet 23)
Loon Lake
Thunder Lake
Pine Island Lake
Mud Lake
CREEK
STATE
WILDLIFE
MANAGEMENT
AREA
TURTLE
Round Lake
RUFNIK
STATE
WILDLIFE
MANAGEMENT
AREA
415 000 FEET
T. 131 N.
MORRISON COUNTY
405 000 FEET
1 870 000 FEET
(Joins sheet 28)

TODD COUNTY, MINNESOTA — SHEET NUMBER 25

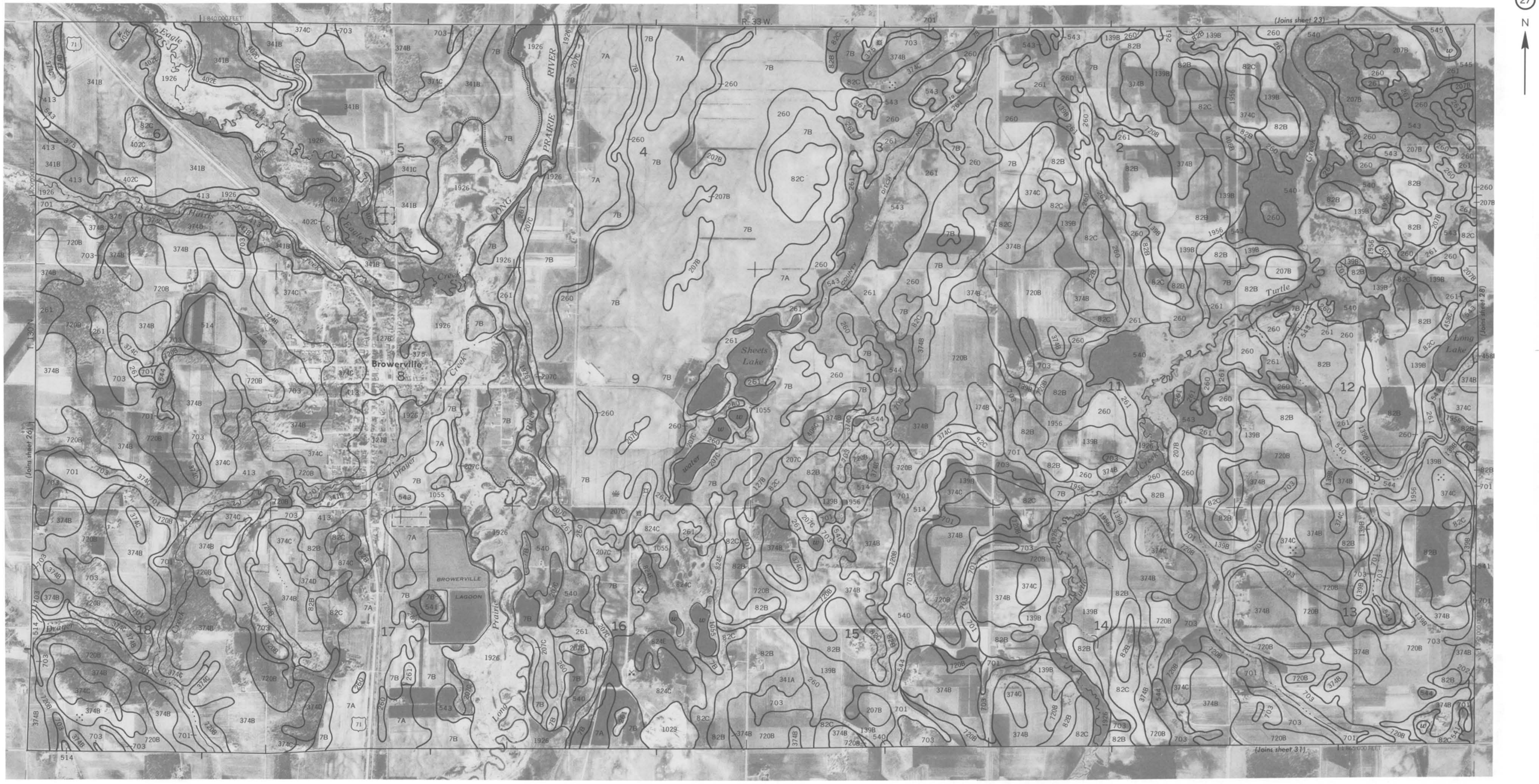

N
R. 35 W.
(Joins sheet 21)
(Joins sheet 26)
(Joins sheet 29)
T. 130 N.
DOUGLAS COUNTY
1 775 000 FEET
1 800 000 FEET
400 000 FEET
390 000 FEET
Eagle Creek
COUNTY DITCH NO. 22
BURLEENE STATE WILDLIFE MANAGEMENT AREA
Dismal Swamp
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

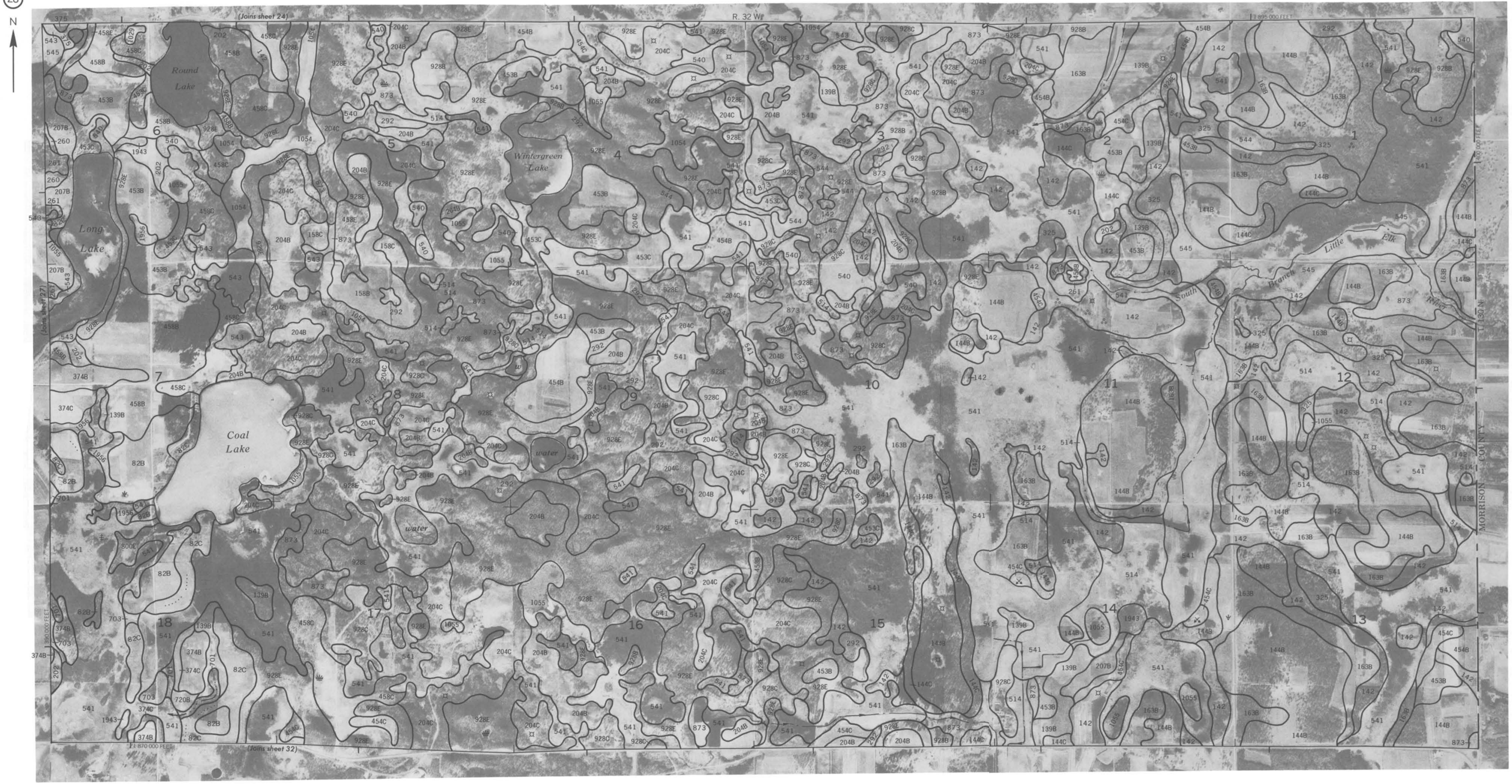
㉖

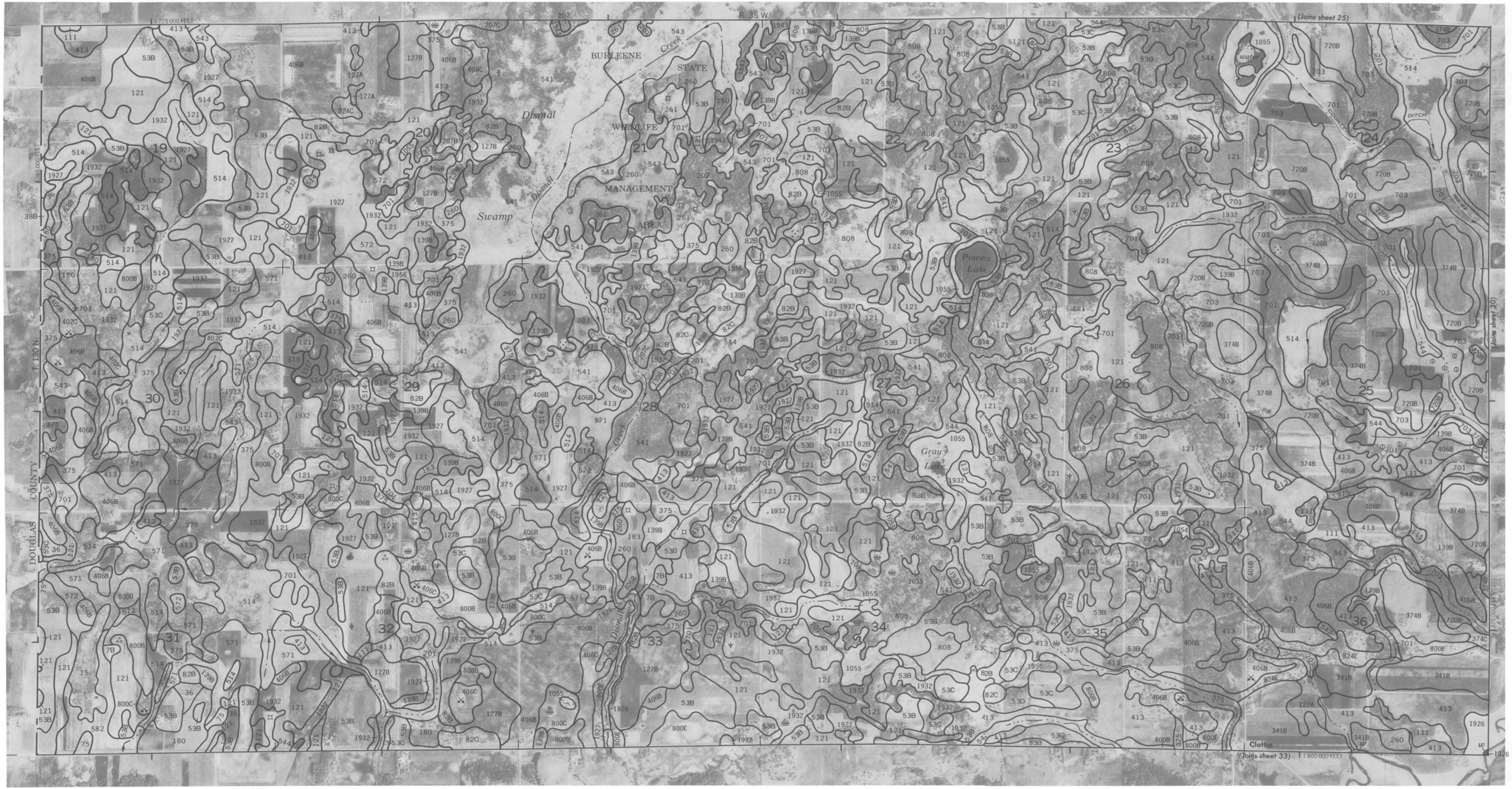
TODD COUNTY, MINNESOTA — SHEET NUMBER 26


N
(Joins sheet 22)
R. 34 W.
835 000 FEET
(Joins sheet 25)
T. 130 N.
400 000 FEET
(Joins sheet 27)
390 000 FEET
1 805 000 FEET
(Joins sheet 30)
COUNTY DITCH NO. 4
COUNTY DITCH NO. 22
Freemans Creek
Harris Creek
Drager Creek
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
374B
374C
720B
701
703
514
541
544
1927
1926
1055
413
543
341B
375
800C
800B
111
261
207C
1029
545

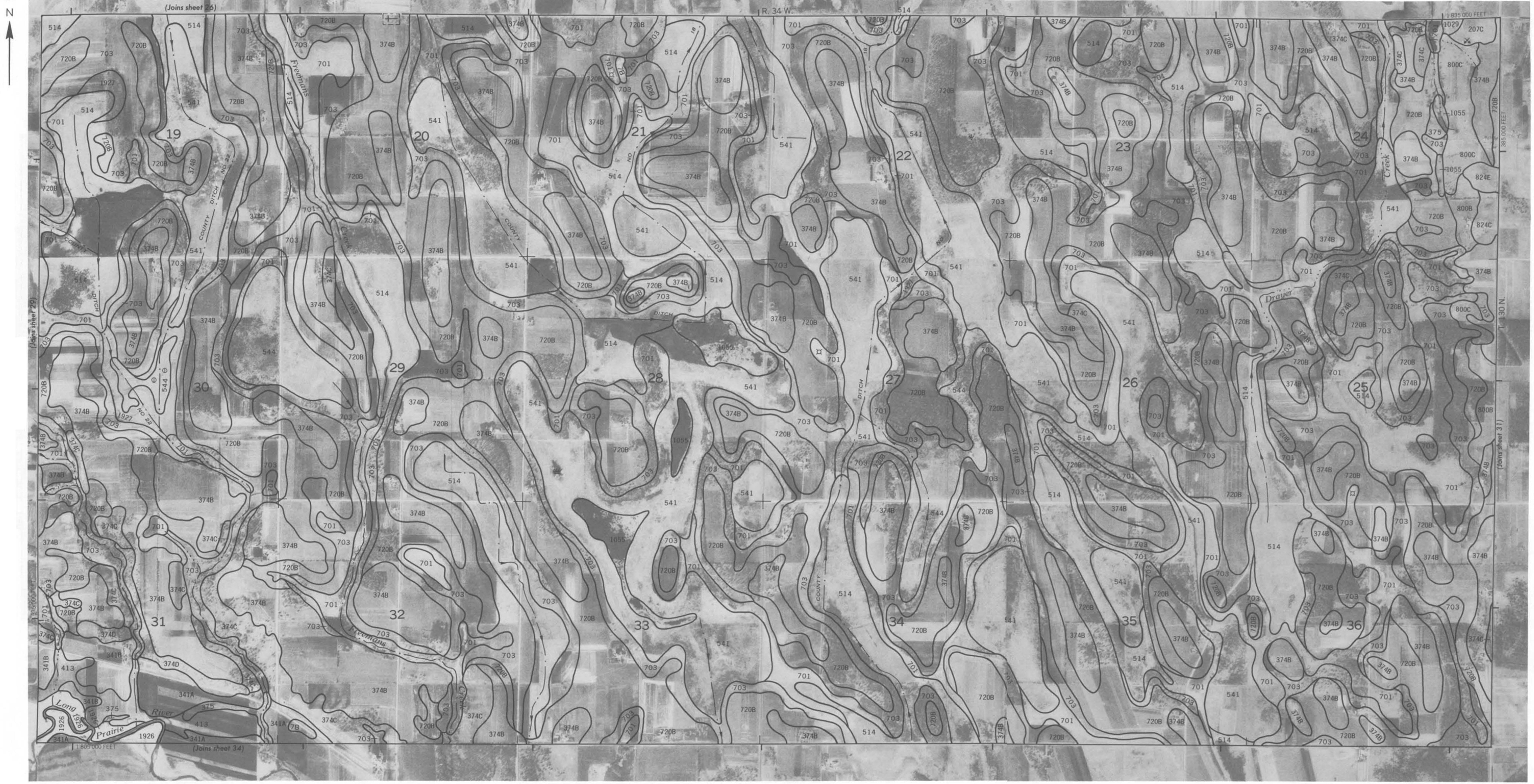
TODD COUNTY, MINNESOTA — SHEET NUMBER 27

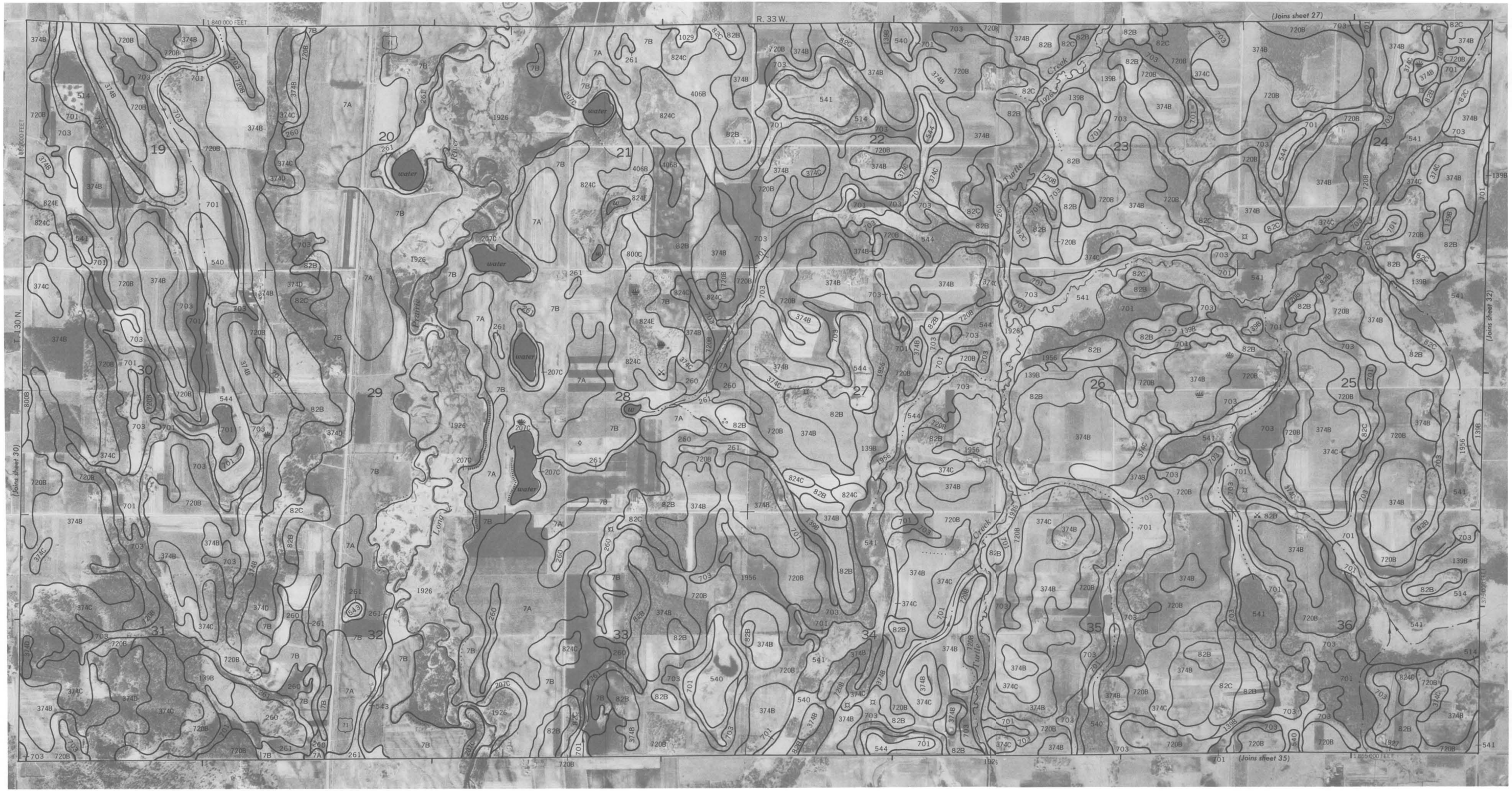

27
N
R. 33 W.
T. 130 N.
1 840 000 FEET
1 865 000 FEET
(Joins sheet 23)
(Joins sheet 28)
(Joins sheet 31)
(Joins sheet 26)
Browerville
BROWERVILLE LAGOON
Sheets Lake
Long Lake
LONG PRAIRIE RIVER
Long Prairie River
Eagle Creek
Harris Creek
Dragon Creek
Turtle Creek
COUNTY DITCH NO. 19
water
71
1
2
3
4
5
6
8
9
10
11
12
13
14
15
16
17
18


N
(Joins sheet 24)
R. 32 W.
1 895 000 FEET
(Joins sheet 27)
(Joins sheet 32)
1 870 000 FEET
390 000 FEET
400 000 FEET
T. 130 N.
MORRISON COUNTY
Round Lake
Long Lake
Wintergreen Lake
Coal Lake
water
South Branch Little Elk River
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

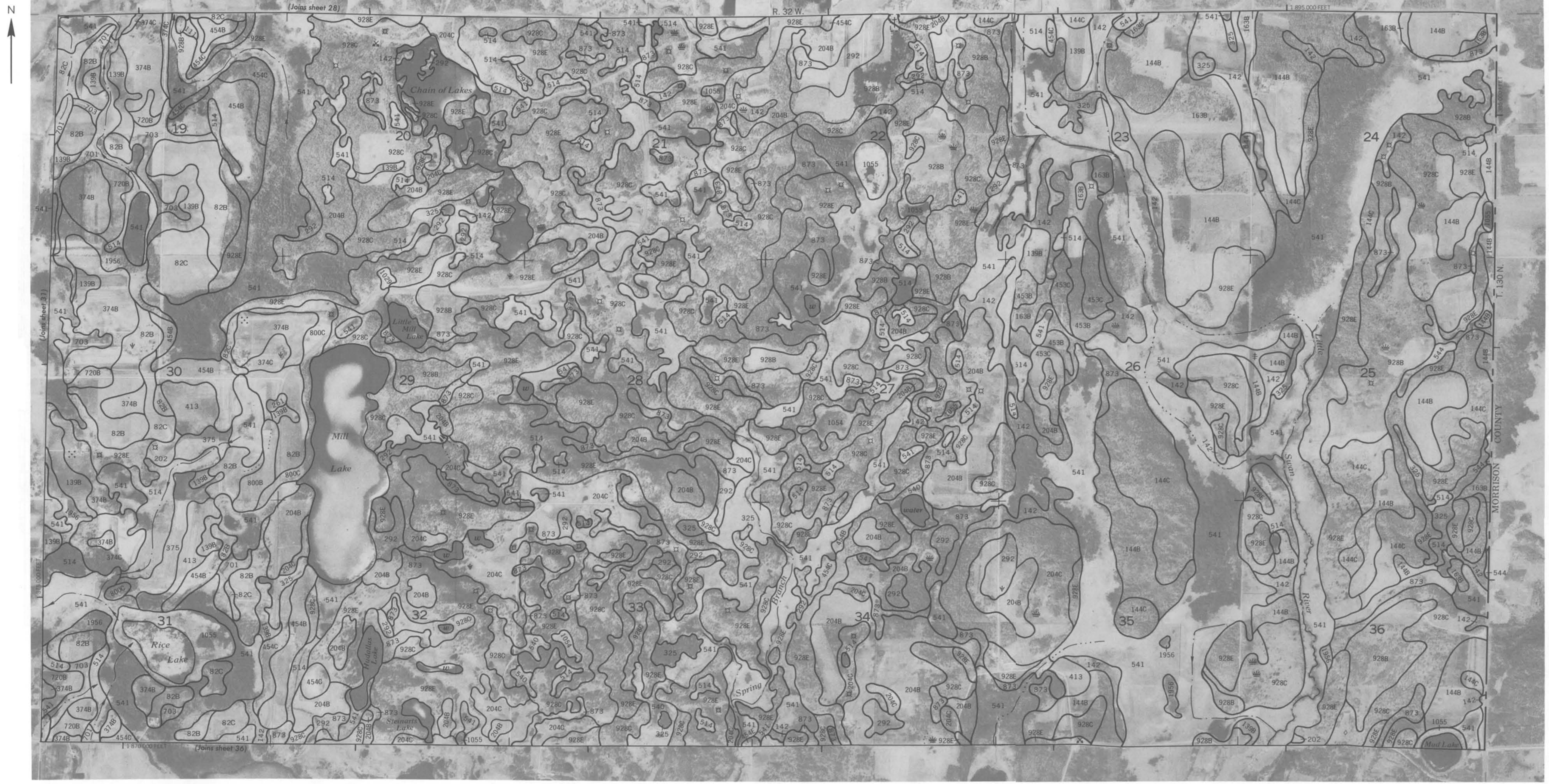

N
R. 35 W.
1 775 000 FEET
(Joins sheet 25)
385 000 FEET
T. 130 N.
DOUGLAS COUNTY
(Joins sheet 30)
(Joins sheet 33)
1 800 000 FEET
BURLEENE STATE WILDLIFE MANAGEMENT AREA
Dismal Swamp
Dismal
Dismal Creek
Creek
Powers Lake
Gray Lake
water
COUNTY DITCH
Clotho
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

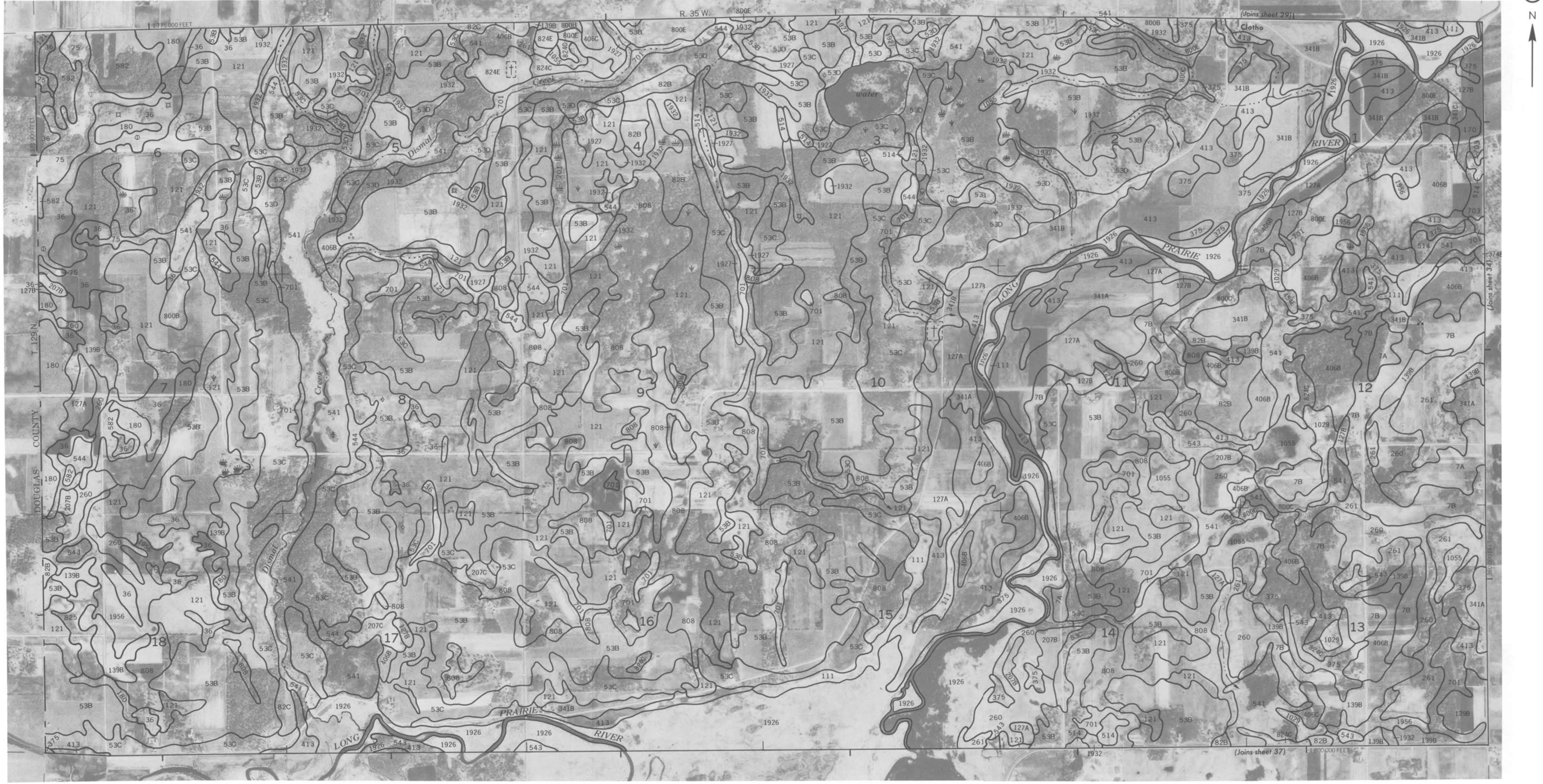
TODD COUNTY, MINNESOTA — SHEET NUMBER 30

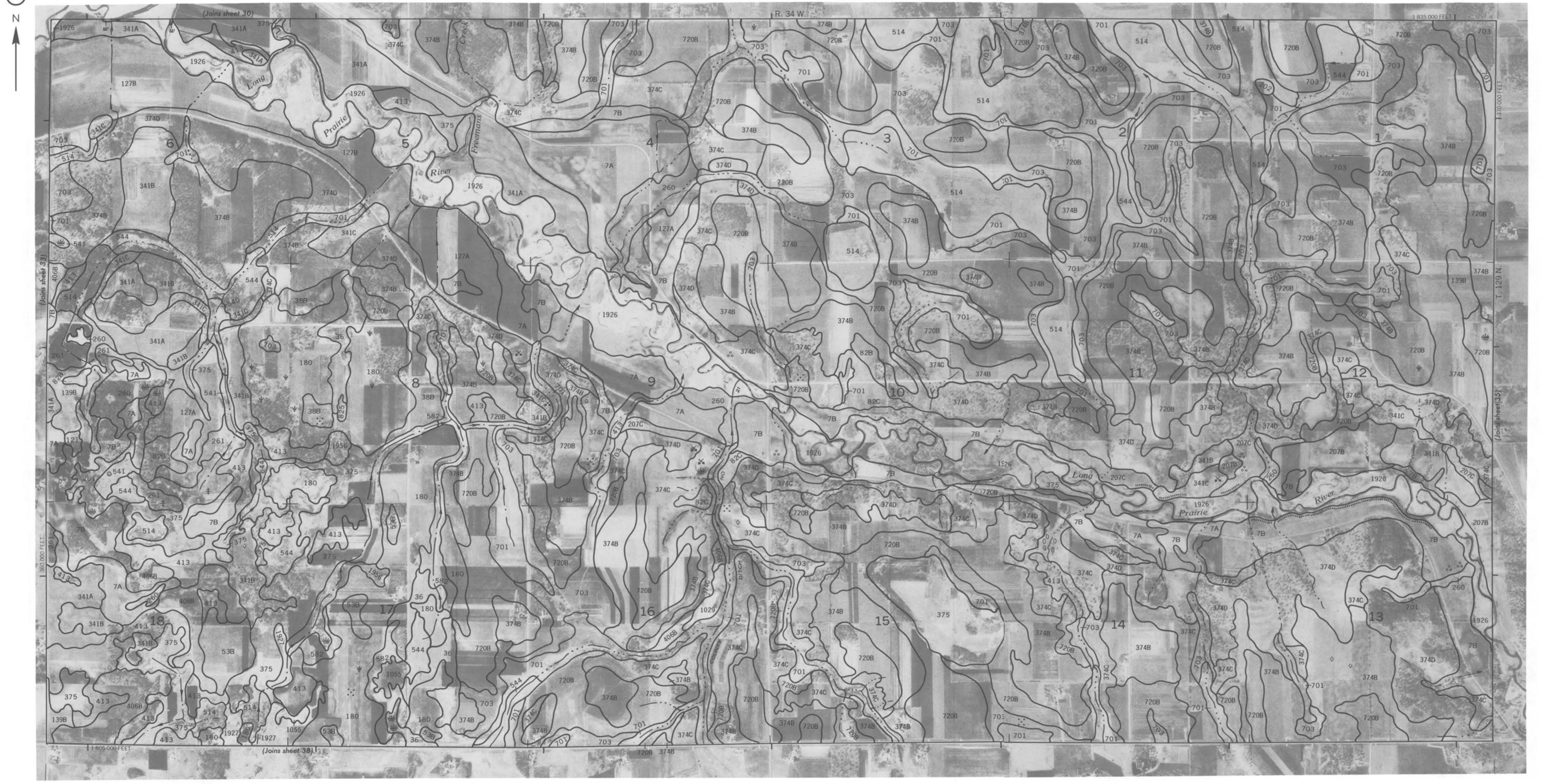

N
(Joins sheet 26)
R. 34 W.
T. 130 N.
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 34)
1 835 000 FEET
385 000 FEET
1 805 000 FEET
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
Fremans Creek
County Ditch No 22
County Ditch No 18
Drayer Creek
Long Prairie River

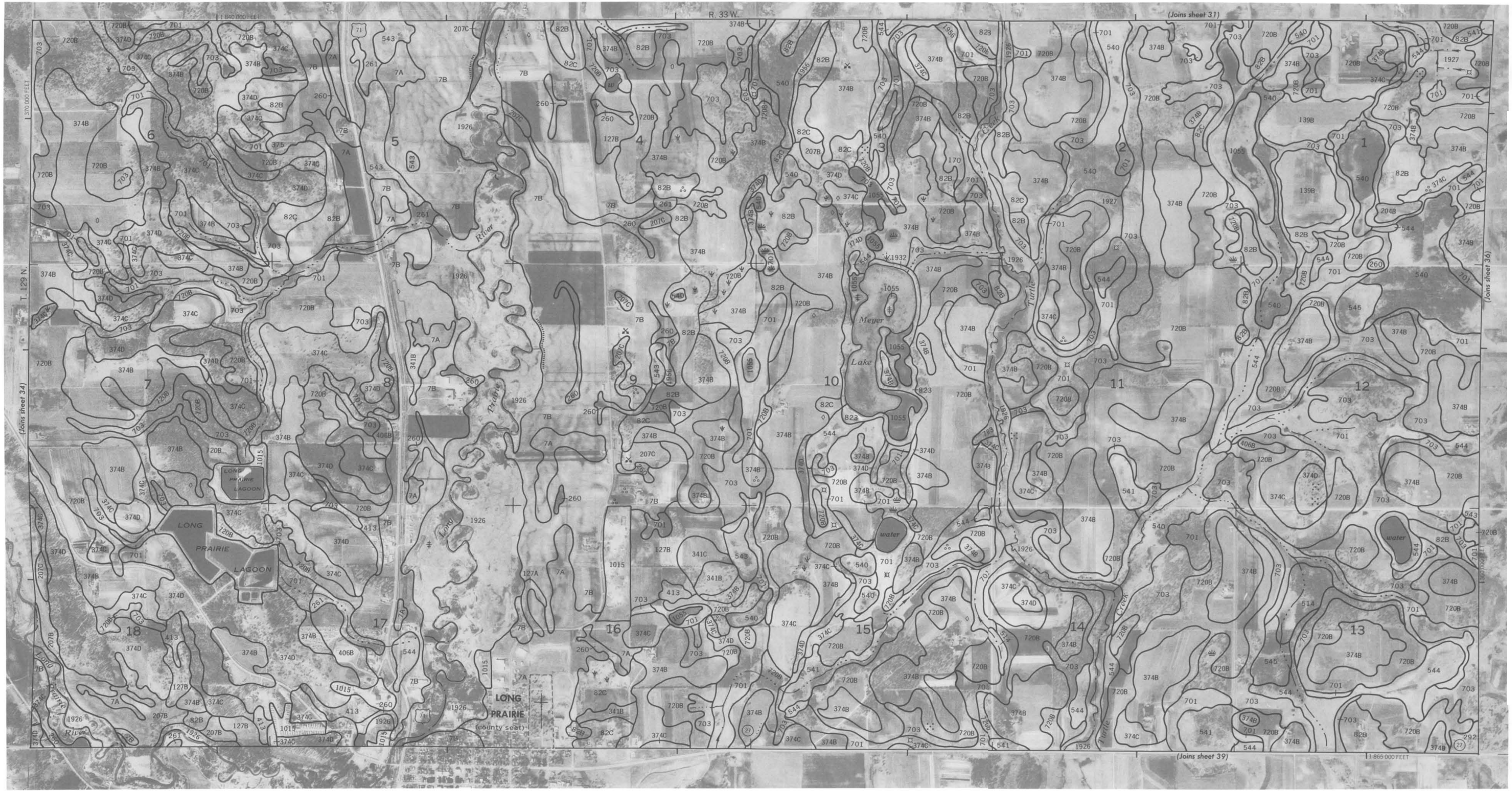

N
R. 33 W.
T. 130 N.
1 840 000 FEET
1 860 000 FEET
(Joins sheet 27)
(Joins sheet 32)
(Joins sheet 35)
(Joins sheet 30)
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
Long Prairie River
Turtle Creek
water
71
374B
720B
701
703
7A
7B
82B
82C
139B
207C
260
261
374C
374D
406B
514
540
541
543
544
800B
800C
824C
824E
1029
1926
1956

TODD COUNTY, MINNESOTA — SHEET NUMBER 32

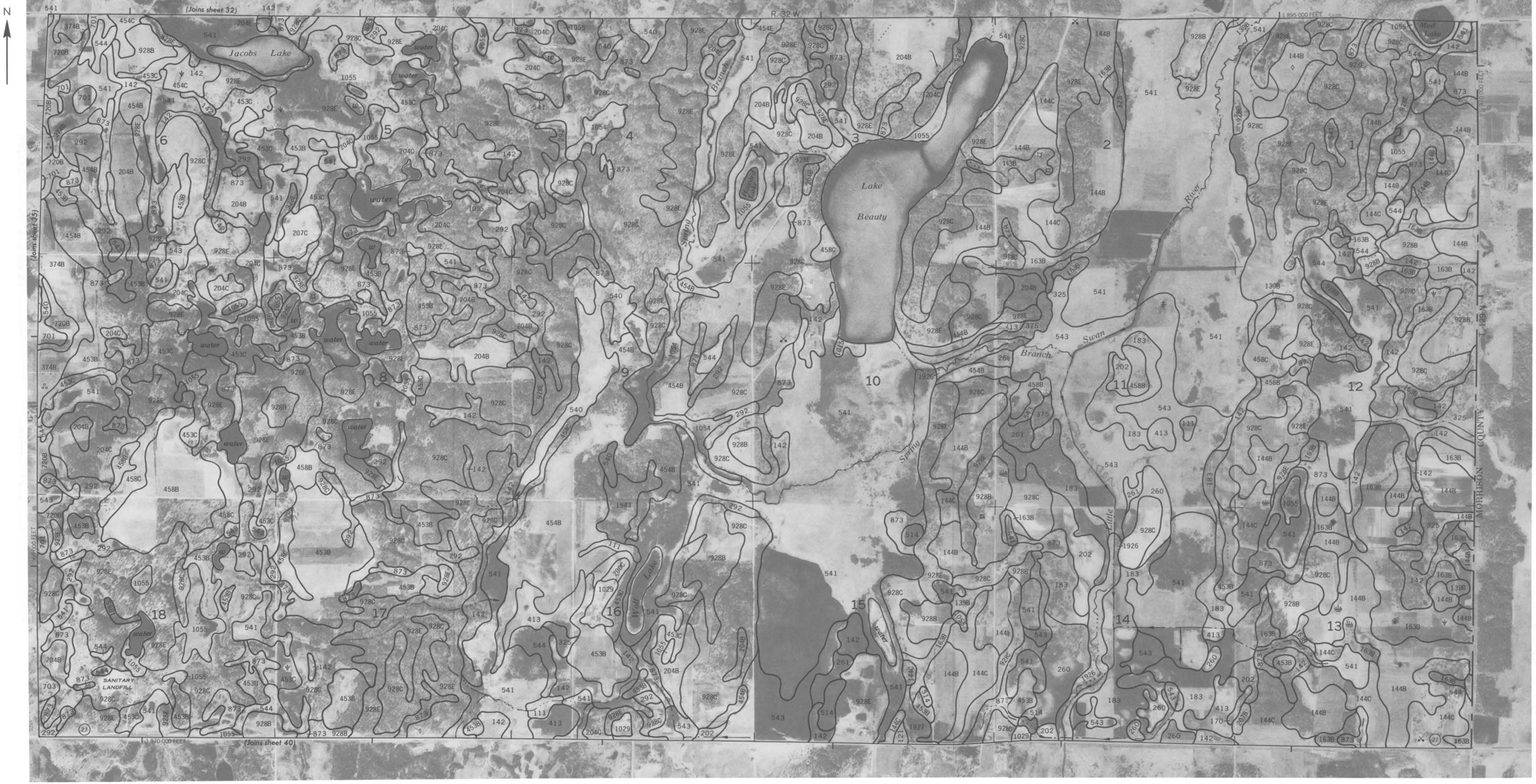

N
(Joins sheet 28)
R. 32 W.
1 895 000 FEET
(Joins sheet 31)
T. 130 N.
MORRISON COUNTY
(Joins sheet 36)
1 870 000 FEET
Chain of Lakes
Little Mill Lake
Mill Lake
Rice Lake
Hudallas Lake
Steinarts Lake
Mud Lake
Spring Branch
Little Swan River
water
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36

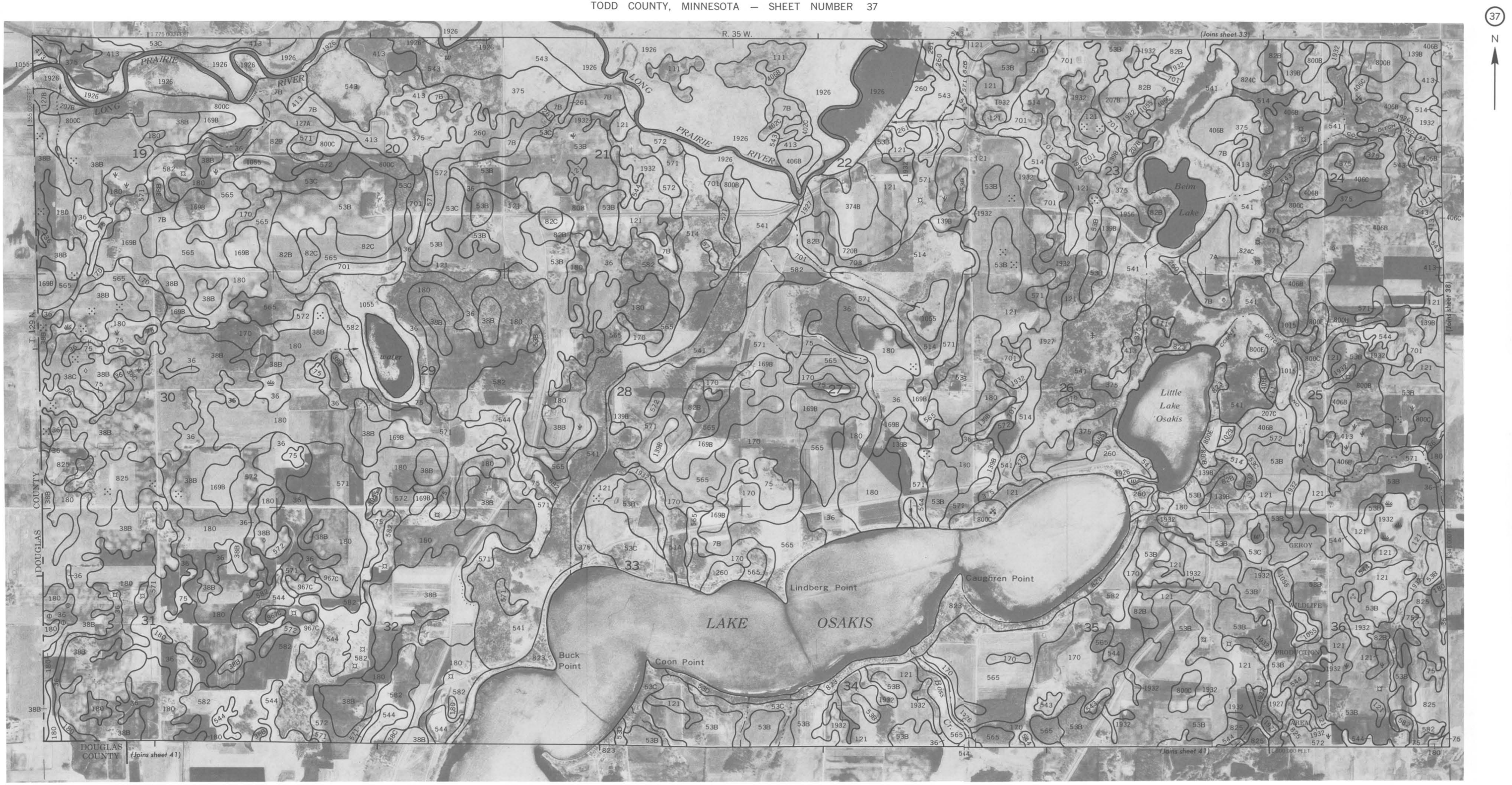

N
R. 35 W.
T. 129 N.
1 775 000 FEET
1 800 000 FEET
(Joins sheet 29)
(Joins sheet 34)
(Joins sheet 37)
DOUGLAS COUNTY
Clotho
water
Dismal Creek
Creek
Dismal
LONG PRAIRIE RIVER
RIVER
PRAIRIE
LONG
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


N
(Joins sheet 30)
R. 34 W.
1 835 000 FEET
370 000 FEET
T. 129 N.
(Joins sheet 35)
(Joins sheet 38)
1 805 000 FEET
360 000 FEET
(Joins sheet 33)
Long
Prairie
River
Freemans
Creek
DITCH
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


R. 33 W.
(Joins sheet 31)
1 840 000 FEET
370 000 FEET
T. 129 N.
(Joins sheet 34)
(Joins sheet 36)
(Joins sheet 39)
1 865 000 FEET
N
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Long Prairie River
Turtle Creek
Meyer Lake
LONG PRAIRIE LAGOON
LONG PRAIRIE
(county seat)
water
71
27

TODD COUNTY, MINNESOTA — SHEET NUMBER 36


N
(Joins sheet 32)
(Joins sheet 35)
(Joins sheet 40)
R. 32 W.
T. 129 N.
1 895 000 FEET
1 870 000 FEET
MORRISON COUNTY
Jacobs Lake
Lake Beauty
Mud Lake
Swan River
Spring Branch
Swan Branch
Little
Wall Lake
SANITARY LANDFILL
water
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


37
N
R. 35 W.
(Joins sheet 33)
(Joins sheet 38)
(Joins sheet 41)
(Joins sheet 41)
T. 129 N.
DOUGLAS COUNTY
DOUGLAS COUNTY
1 775 000 FEET
355 000 FEET
LONG PRAIRIE RIVER
LONG PRAIRIE RIVER
Beim Lake
Little Lake Osakis
LAKE OSAKIS
water
Buck Point
Coon Point
Lindberg Point
Caughren Point
Boss Cr.
GEROY
WILDLIFE PRODUCTION AREA
COUNTY DITCH NO 32
COUNTY DITCH NO
19
20
21
22
23
24
25
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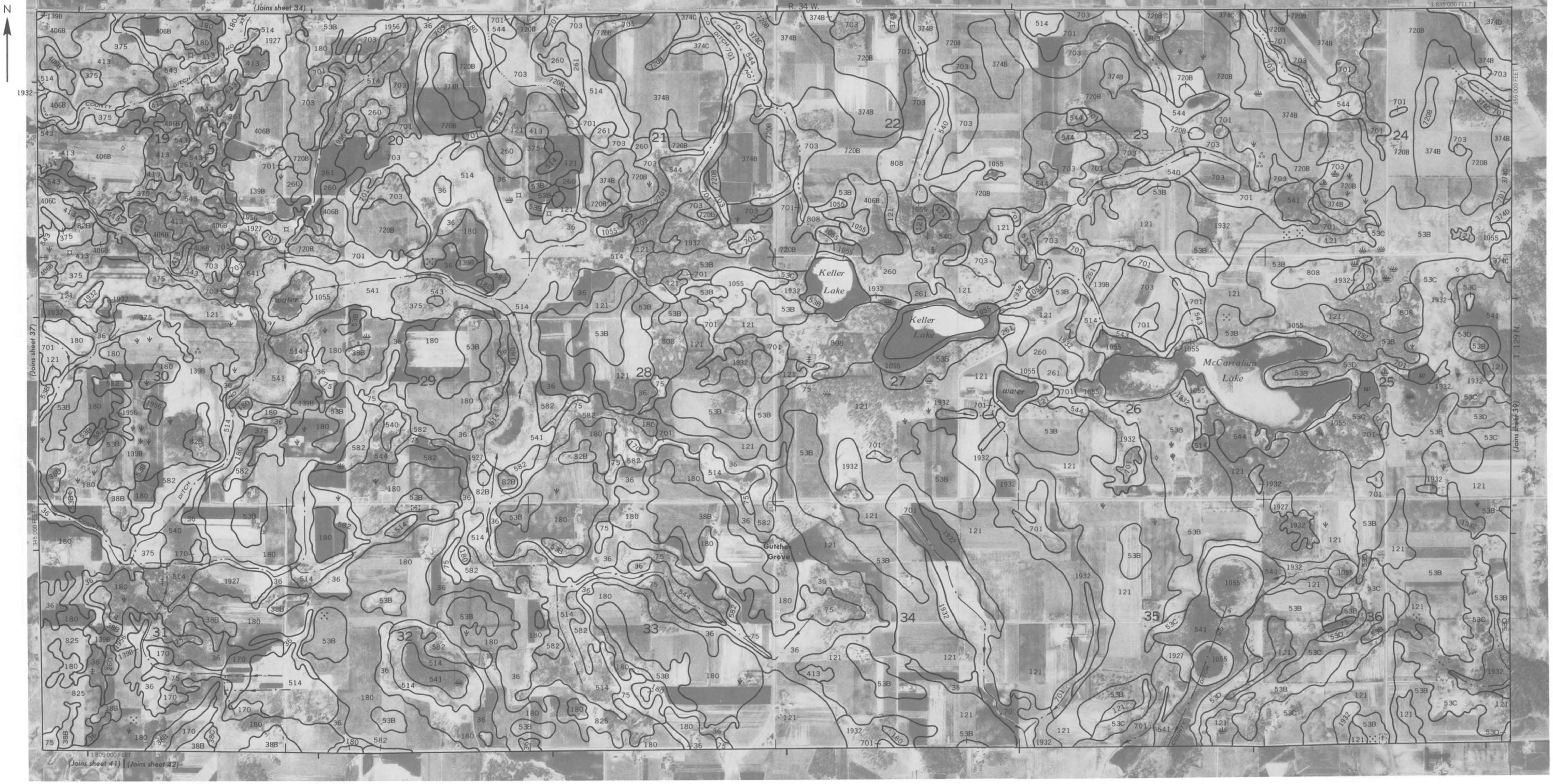
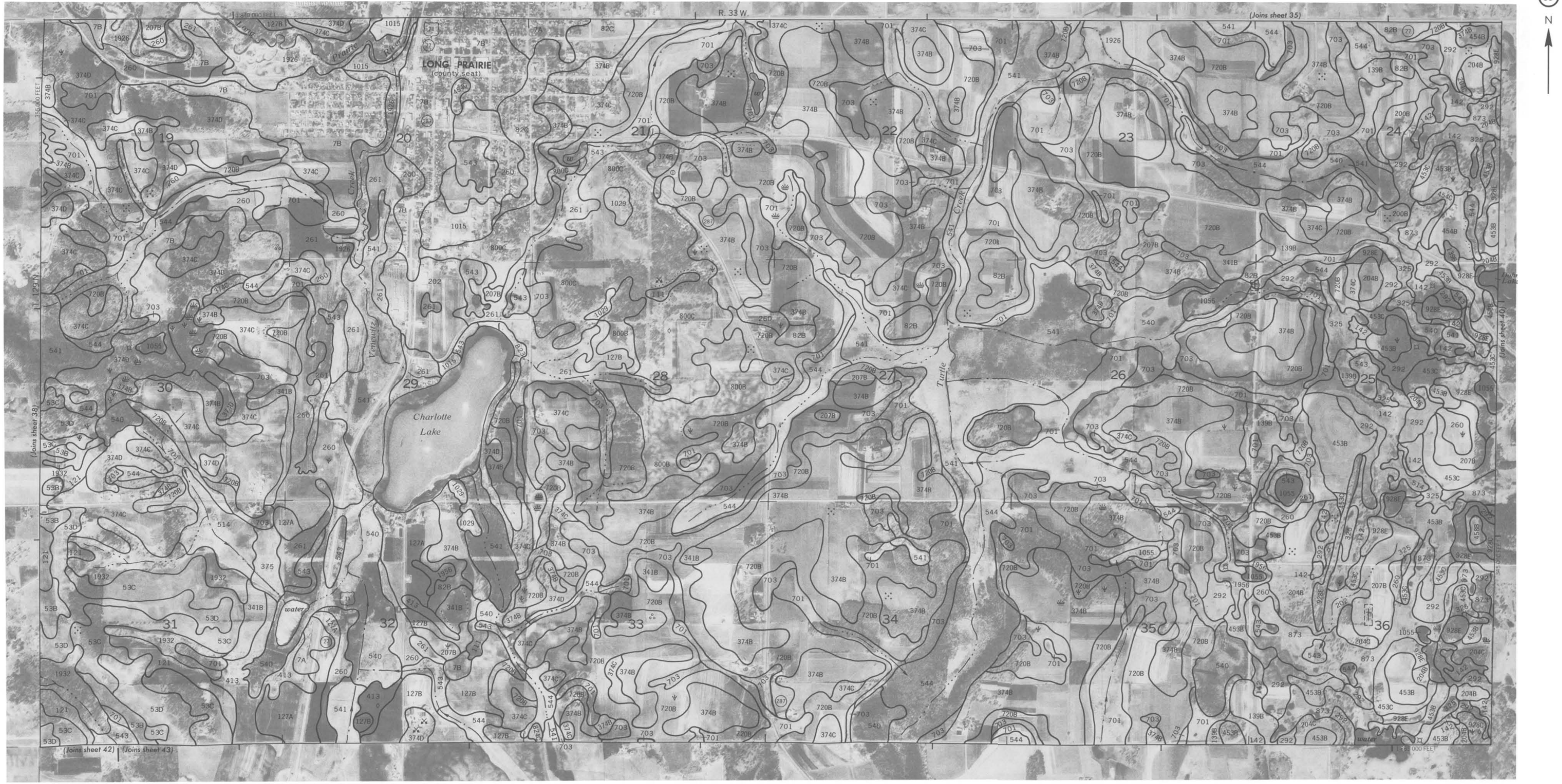
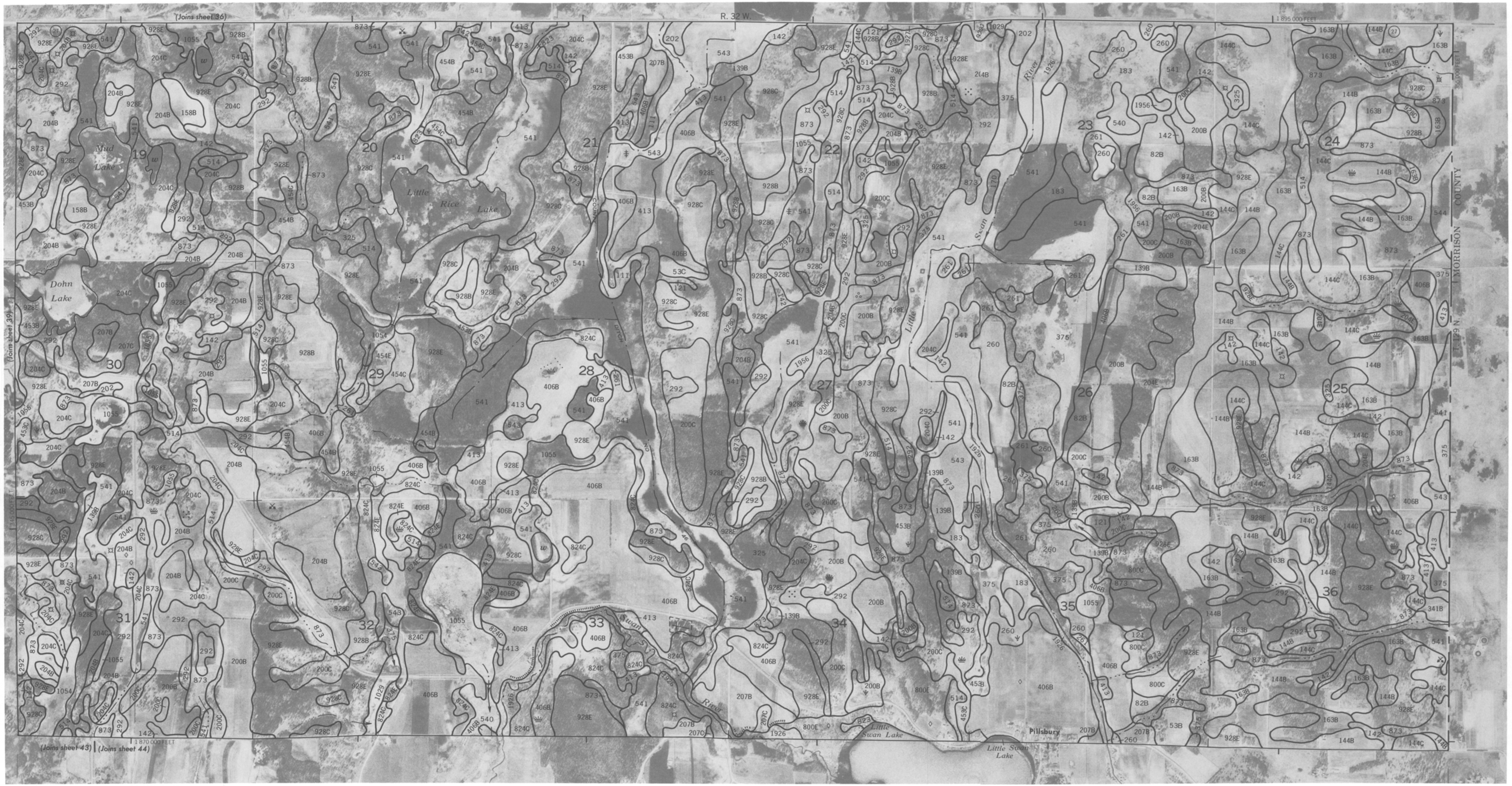
27
28
29
30
31
32
33
34
35
36

TODD COUNTY, MINNESOTA — SHEET NUMBER 38

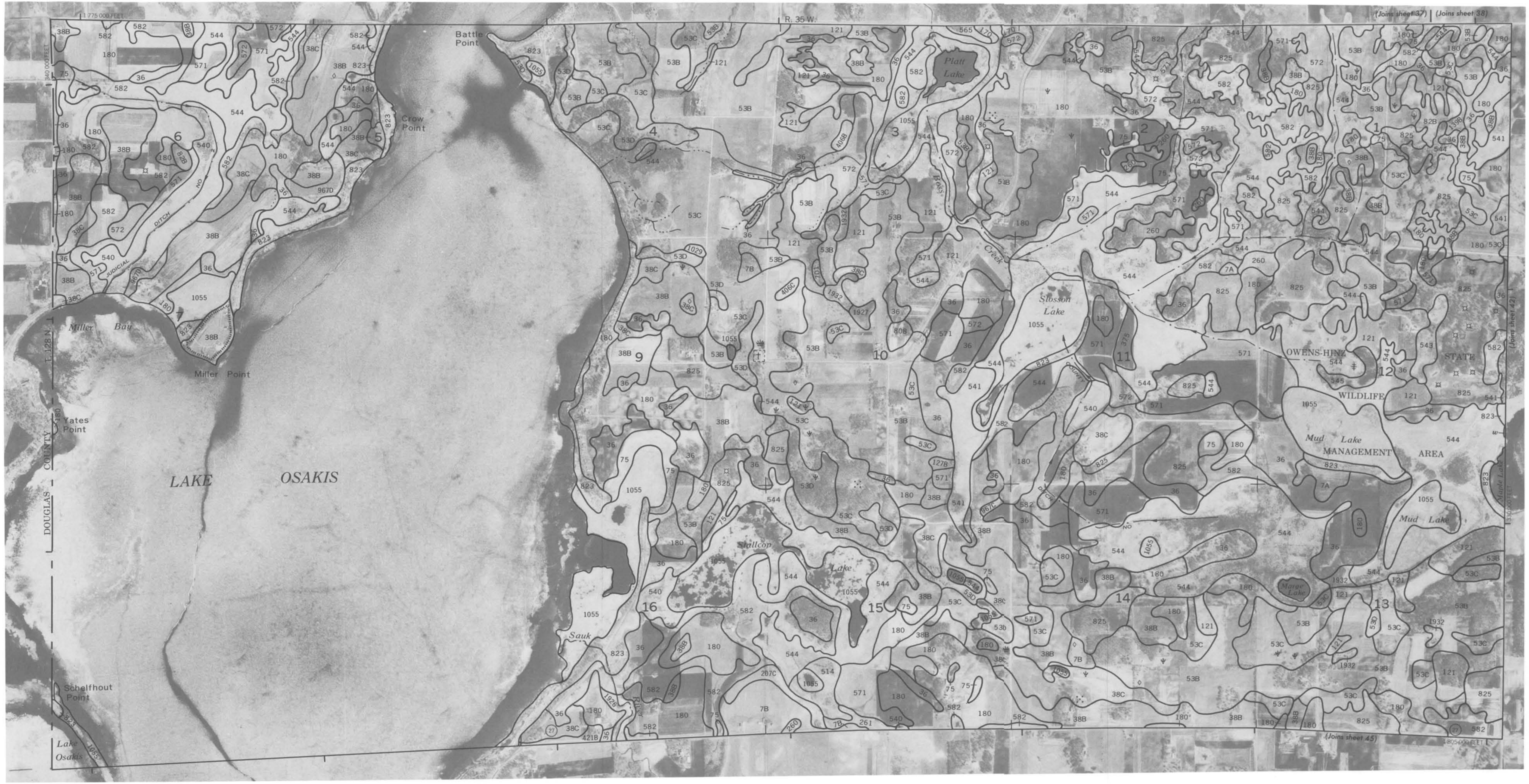

N
(Joins sheet 34)
R. 34 W.
1 835 000 FEET
355 000 FEET
T. 129 N.
(Joins sheet 37)
(Joins sheet 39)
345 000 FEET
1 805 000 FEET
(Joins sheet 41)
(Joins sheet 42)
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
Keller Lake
Keller Lake
McCarrahan Lake
Gutches Grove
water
water
COUNTY DITCH NO
CO. DITCH 701
1932

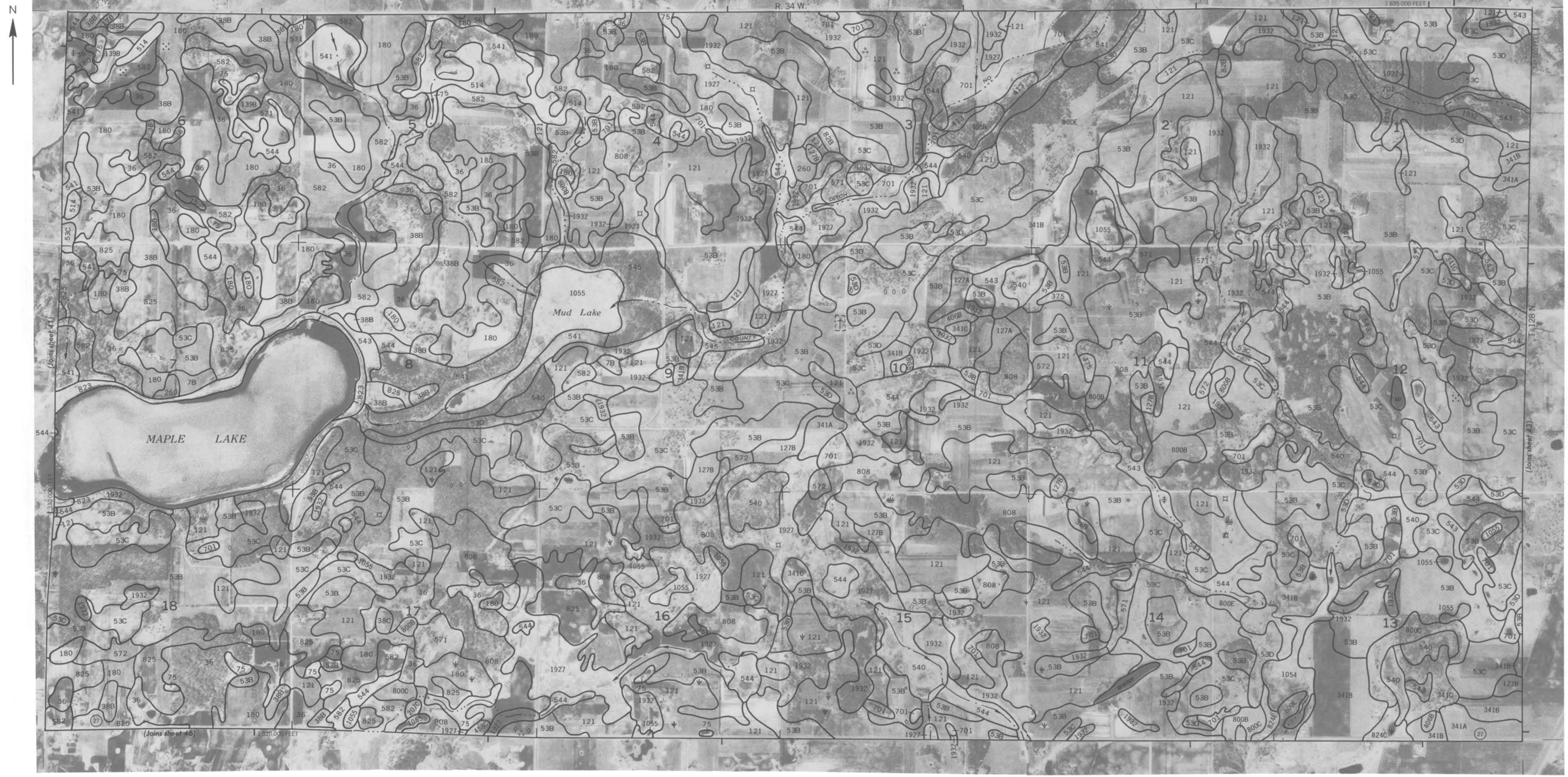

N
R. 33 W.
(Joins sheet 35)
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 43)
T. 129 N.
1 840 000 FEET
355 000 FEET
LONG PRAIRIE
(county seat)
Long Prairie River
Creek
Venewitz Creek
Charlotte Lake
Turtle Creek
water
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36

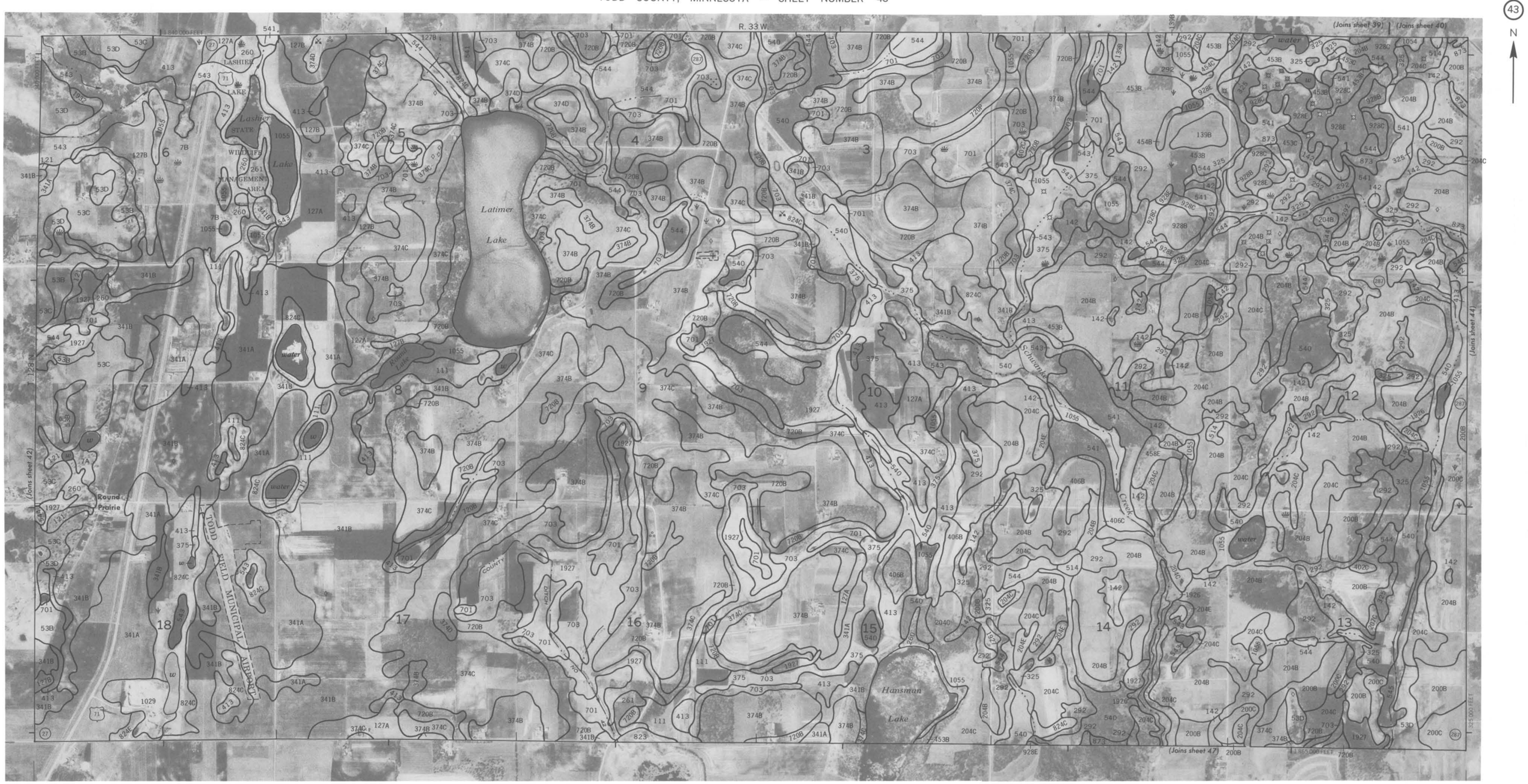
TODD COUNTY, MINNESOTA — SHEET NUMBER 40

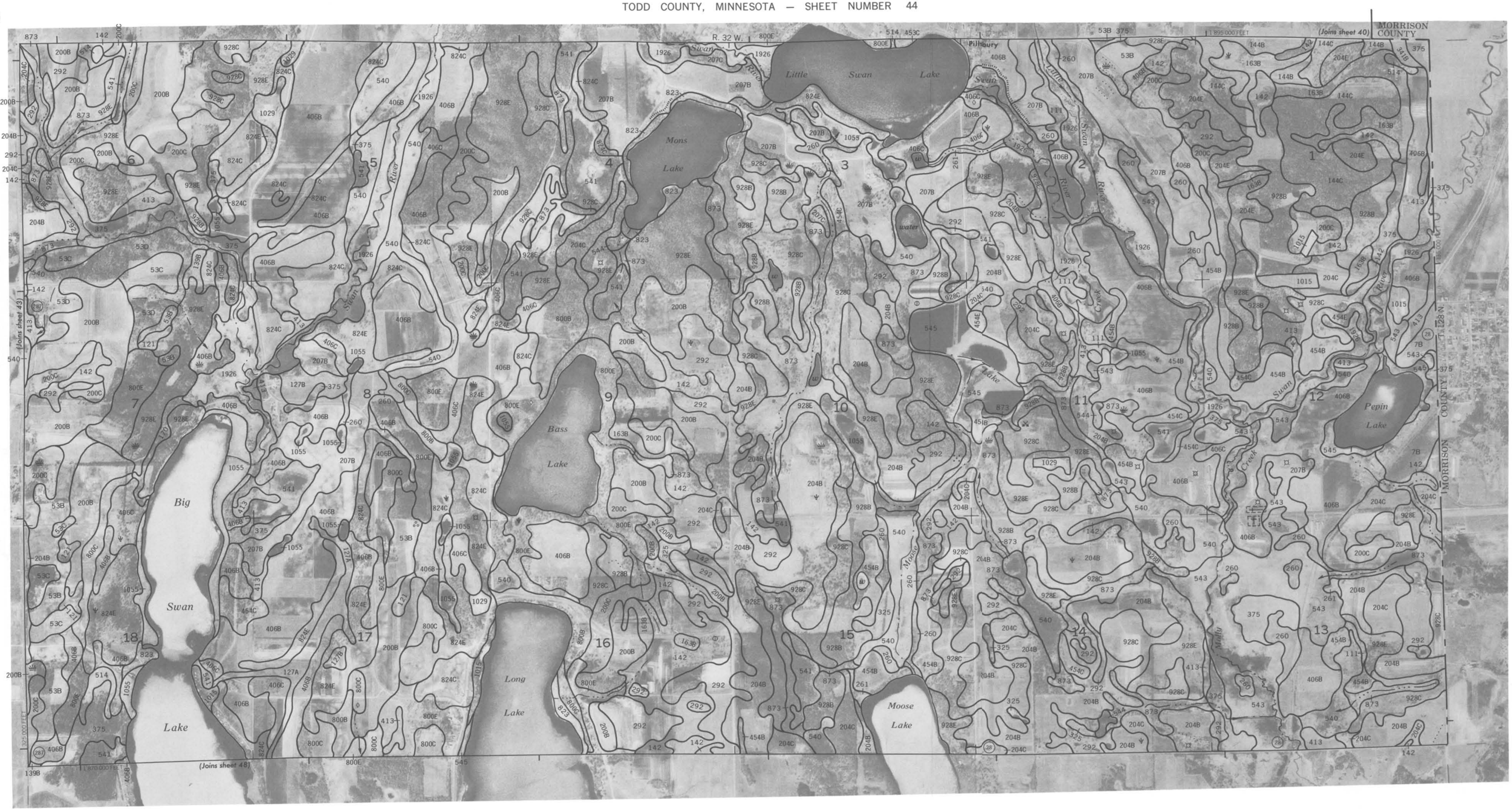

N
(Joins sheet 36)
R. 32 W.
1 895 000 FEET
(Joins sheet 39)
(Joins sheet 43)
(Joins sheet 44)
1 870 000 FEET
T. 129 N.
MORRISON COUNTY
Mud Lake
Dohn Lake
Little Rice Lake
Swan River
Little Swan River
Little Swan Lake
Pillsbury
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

TODD COUNTY, MINNESOTA — SHEET NUMBER 41


N
(Joins sheet 37)
(Joins sheet 38)
(Joins sheet 42)
(Joins sheet 45)
R. 35 W.
T. 128 N.
1 775 000 FEET
340 000 FEET
1 805 000 FEET
310 000 FEET
DOUGLAS COUNTY
Battle Point
Crow Point
Miller Bay
Miller Point
Yates Point
Schelfhout Point
LAKE OSAKIS
Lake Osakis
Sauk River
Platt Lake
Slosson Lake
Stallcop Lake
Marge Lake
Mud Lake
Maple Lake
OWENS-HINZ STATE WILDLIFE MANAGEMENT AREA
Mud Lake MANAGEMENT AREA
JUDICIAL DITCH NO
Bass Creek
COUNTY DITCH NO
1
2
3
4
5
6
7
9
10
11
12
13
14
15
16
27


N
R. 34 W.
(Joins sheet 38)
(Joins sheet 39)
1 835 000 FEET
(Joins sheet 41)
(Joins sheet 43)
(Joins sheet 46)
1 810 000 FEET
T. 128 N.
MAPLE LAKE
Mud Lake
County
Ditch
Water
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


43
N
R. 33 W.
T. 128 N.
(Joins sheet 39)
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 47)
1 840 000 FEET
1 865 000 FEET
325 000 FEET
Latimer Lake
Lashier Lake
LASHIER LAKE
Lashier STATE WILDLIFE MANAGEMENT AREA
Round Lake
Hansman Lake
Round Prairie
TODD FIELD MUNICIPAL AIRPORT
Schwanke Creek
COUNTY DITCH NO 42
water
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


N
R. 32 W.
Pillsbury
(Joins sheet 40)
MORRISON COUNTY
1 895 000 FEET
Little Swan Lake
Swan River
Mons Lake
Little Swan River
Swan River
Swan Lake
Swan Lake Creek
Bass Lake
Big Swan Lake
Long Lake
Moose Lake
Moose Creek
Pepin Lake
Mulig Creek
MORRISON COUNTY
T. 128 N.
(Joins sheet 43)
(Joins sheet 48)
1 870 000 FEET
325 000 FEET
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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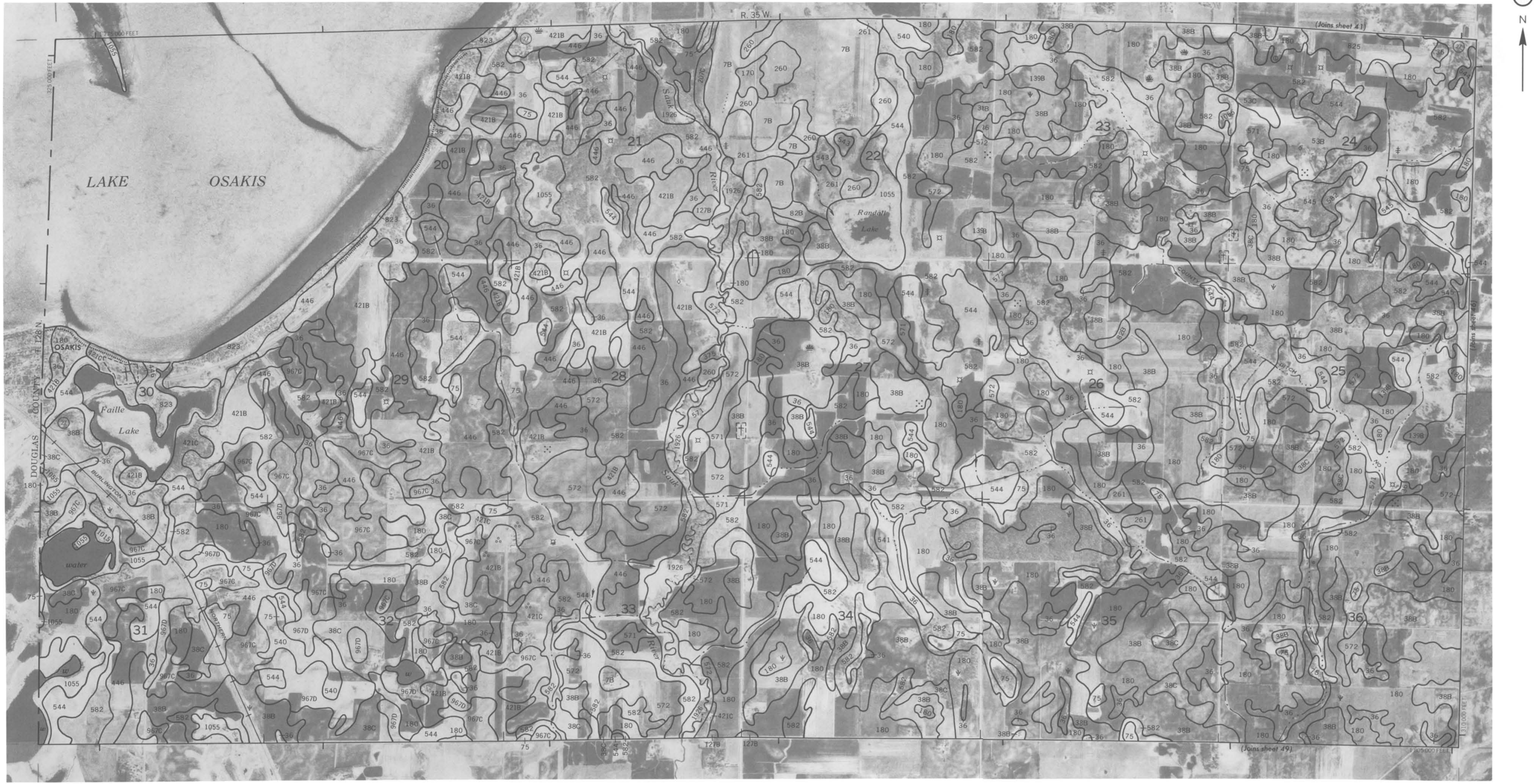
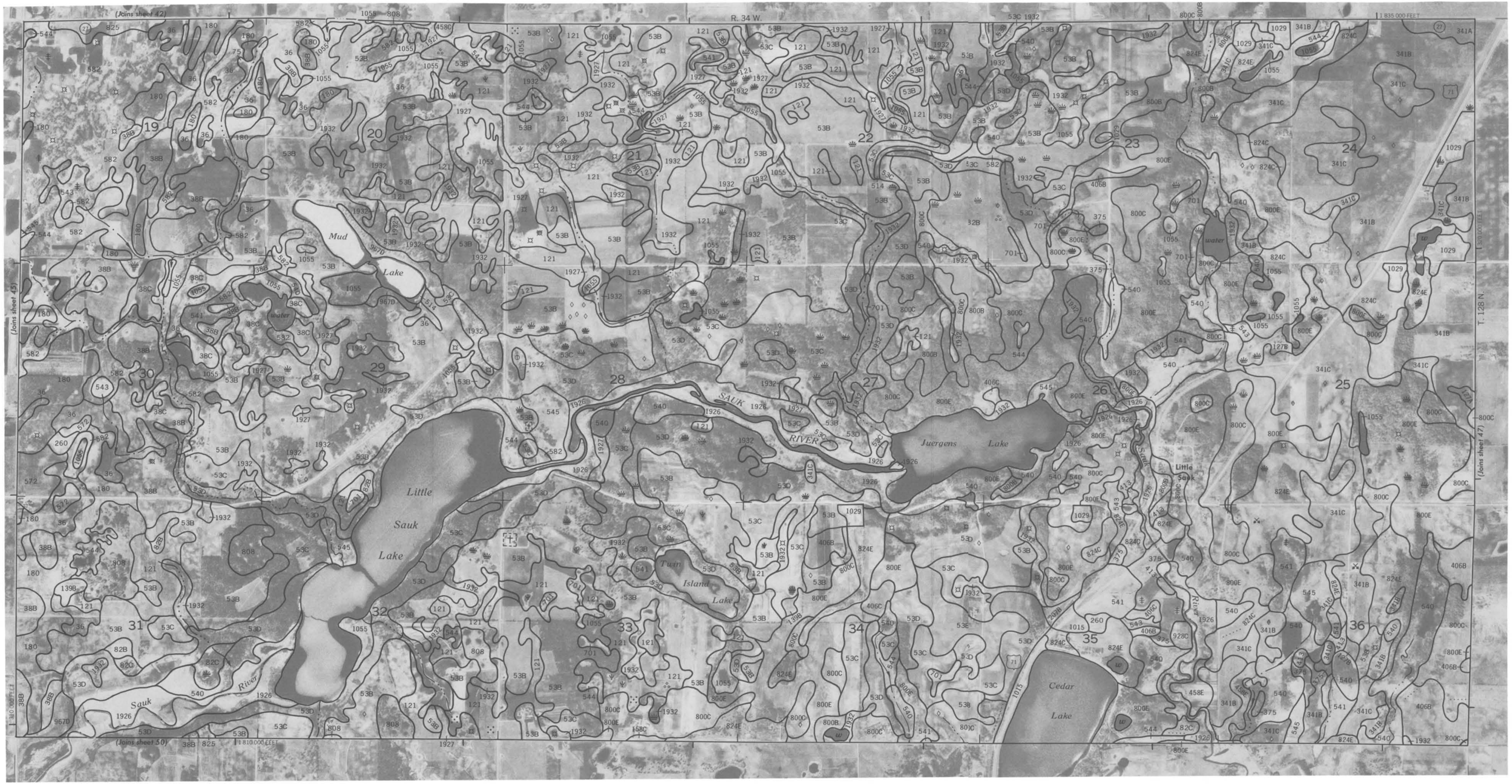
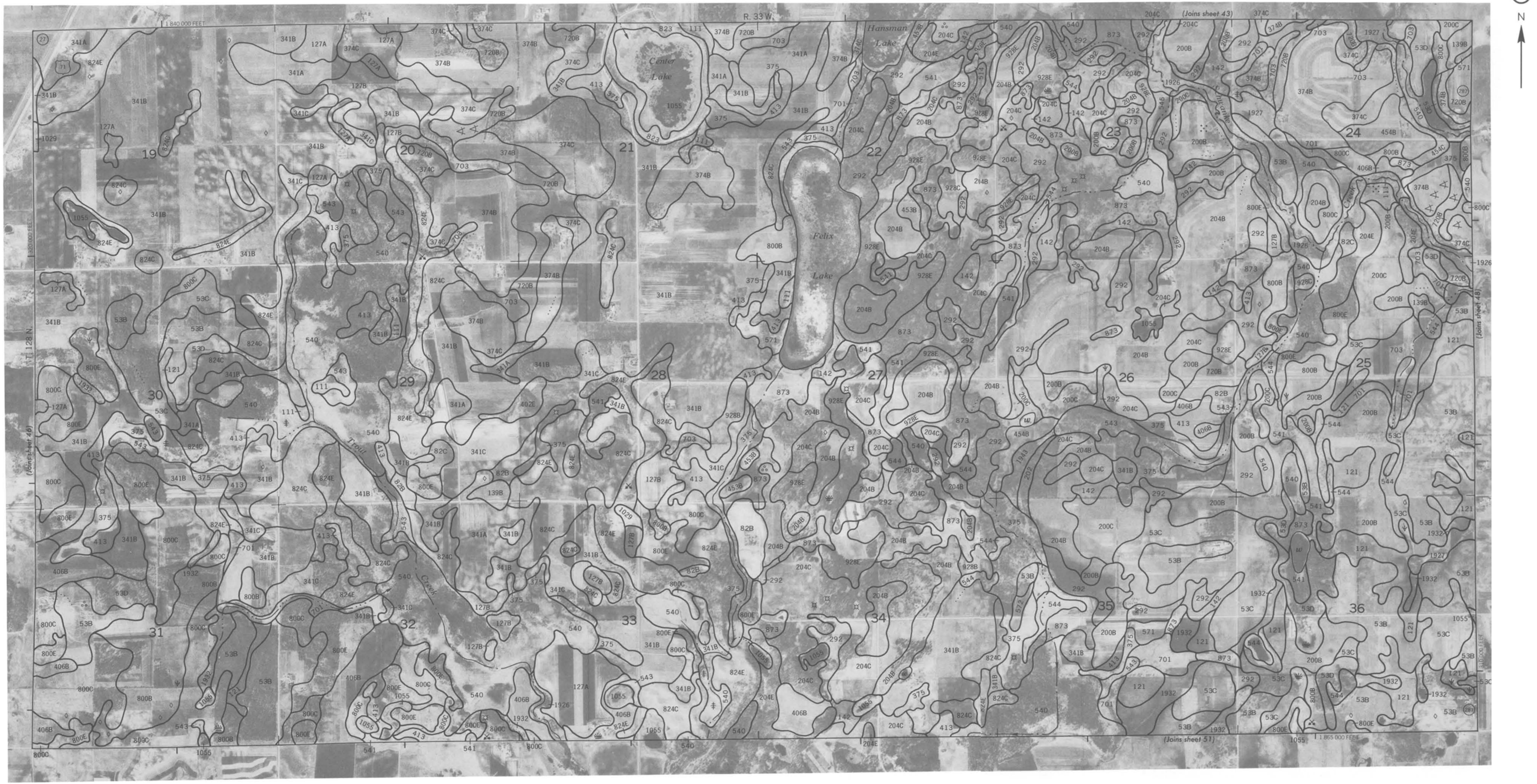
16
17
18


N
R. 35 W.
(Joins sheet 41)
(Joins sheet 46)
(Joins sheet 49)
T. 128 N.
T.127 B.
1 735 000 FEET
325 000 FEET
310 000 FEET
1 805 000 FEET
LAKE
OSAKIS
OSAKIS
DOUGLAS
COUNTY
Faille
Lake
water
Randall
Lake
Sauk
River
Sauk
River
BURLINGTON
NORTHERN
COUNTY
DITCH
NO
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

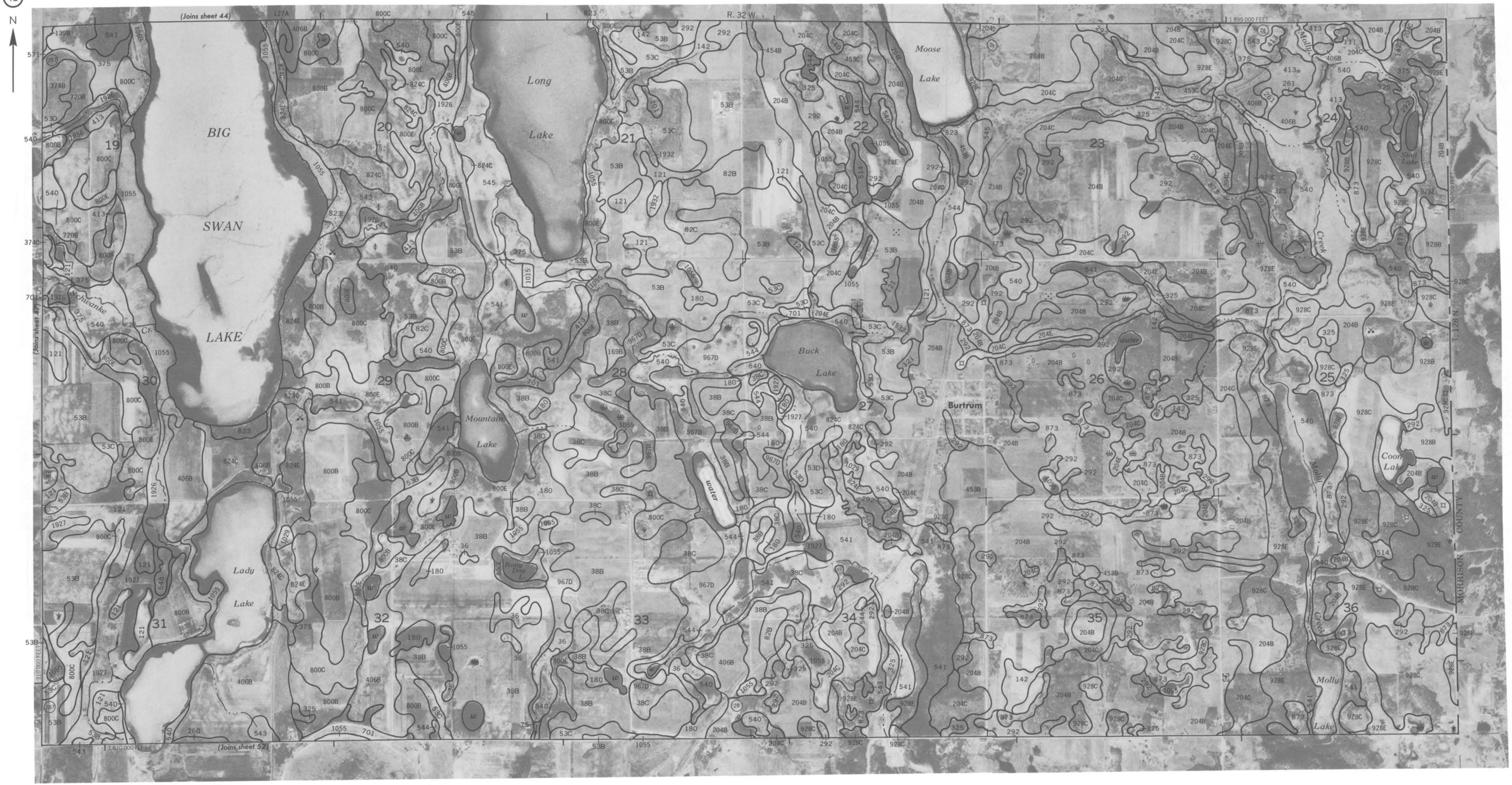
N

TODD COUNTY, MINNESOTA — SHEET NUMBER 46

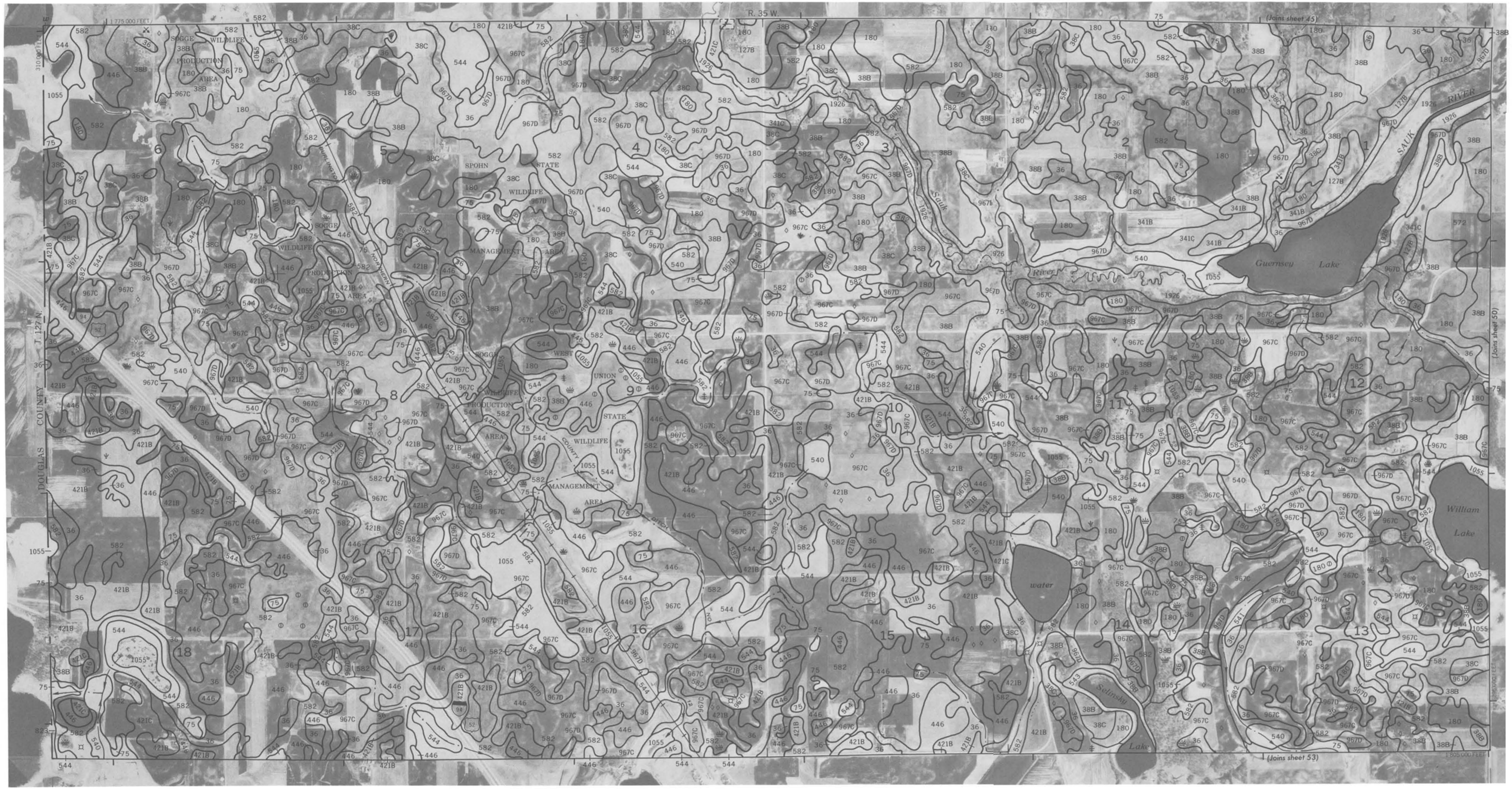

(Joins sheet 42)
R. 34 W.
1 835 000 FEET
(Joins sheet 45)
(Joins sheet 47)
T. 128 N.
(Joins sheet 50)
1 810 000 FEET
310 000 FEET
27
71
Mud Lake
Little Sauk Lake
Twin Island Lake
Juergens Lake
Cedar Lake
Little Sauk
Sauk River
Sauk River
water
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36


N
(Joins sheet 43)
(Joins sheet 48)
(Joins sheet 51)
(Joins sheet 46)
R. 33 W.
T. 128 N.
1 840 000 FEET
1 865 000 FEET
Center Lake
Felix Lake
Hansman Lake
Trout Creek
Creek
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

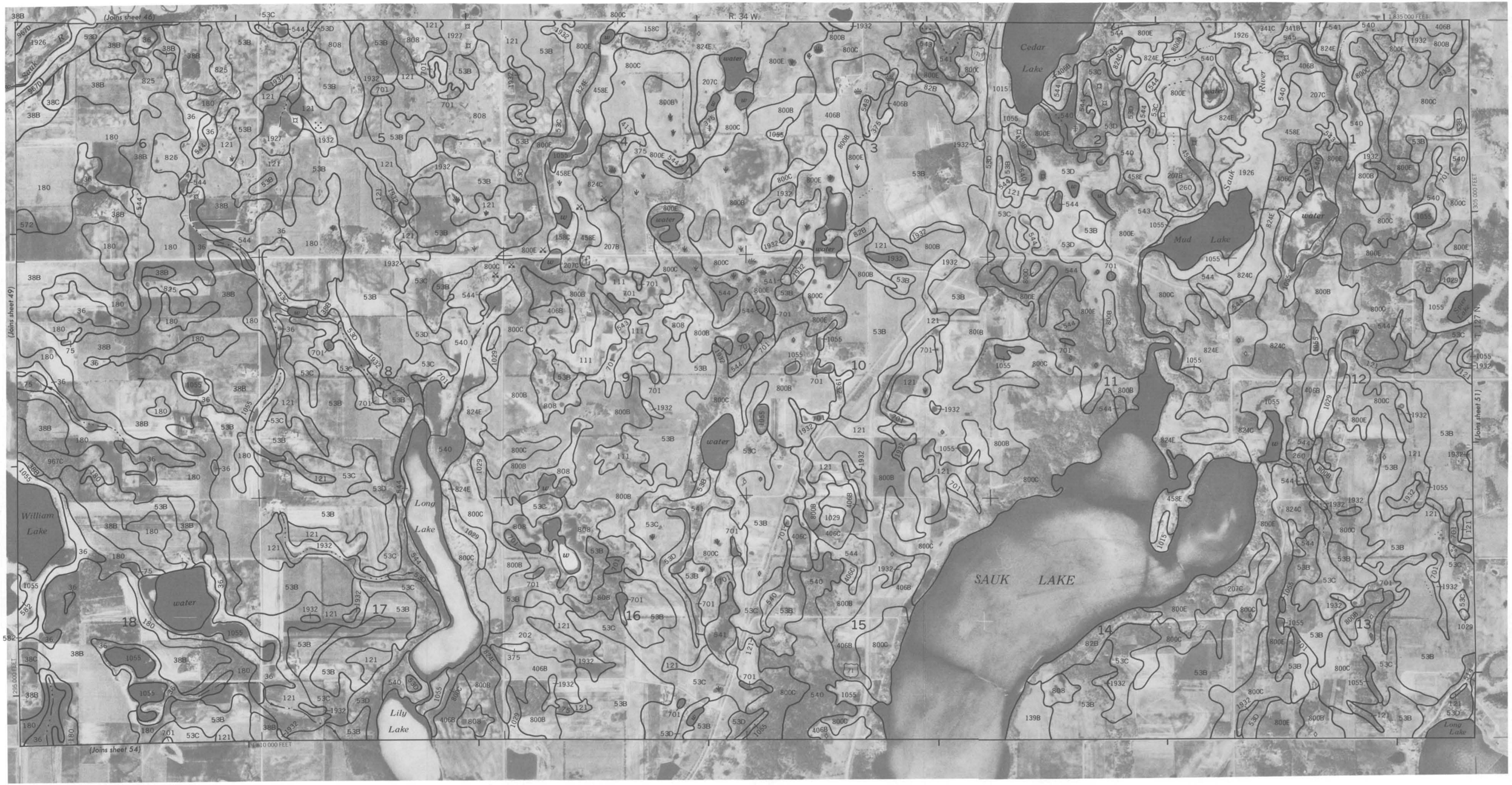
TODD COUNTY, MINNESOTA — SHEET NUMBER 48


N
(Joins sheet 44)
R. 32 W.
1 895 000 FEET
BIG SWAN LAKE
Long Lake
Moose Lake
Molly Creek
Stoll Lake
Buck Lake
Mountain Lake
Bony Dog L.
Burtrum
water
Coon Lake
Lady Lake
Molly Lake
Ochwanke Cr.
(Joins sheet 47)
T. 128 N.
MORRISON COUNTY
330 000 FEET
310 000 FEET
1 870 000 FEET
(Joins sheet 52)
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

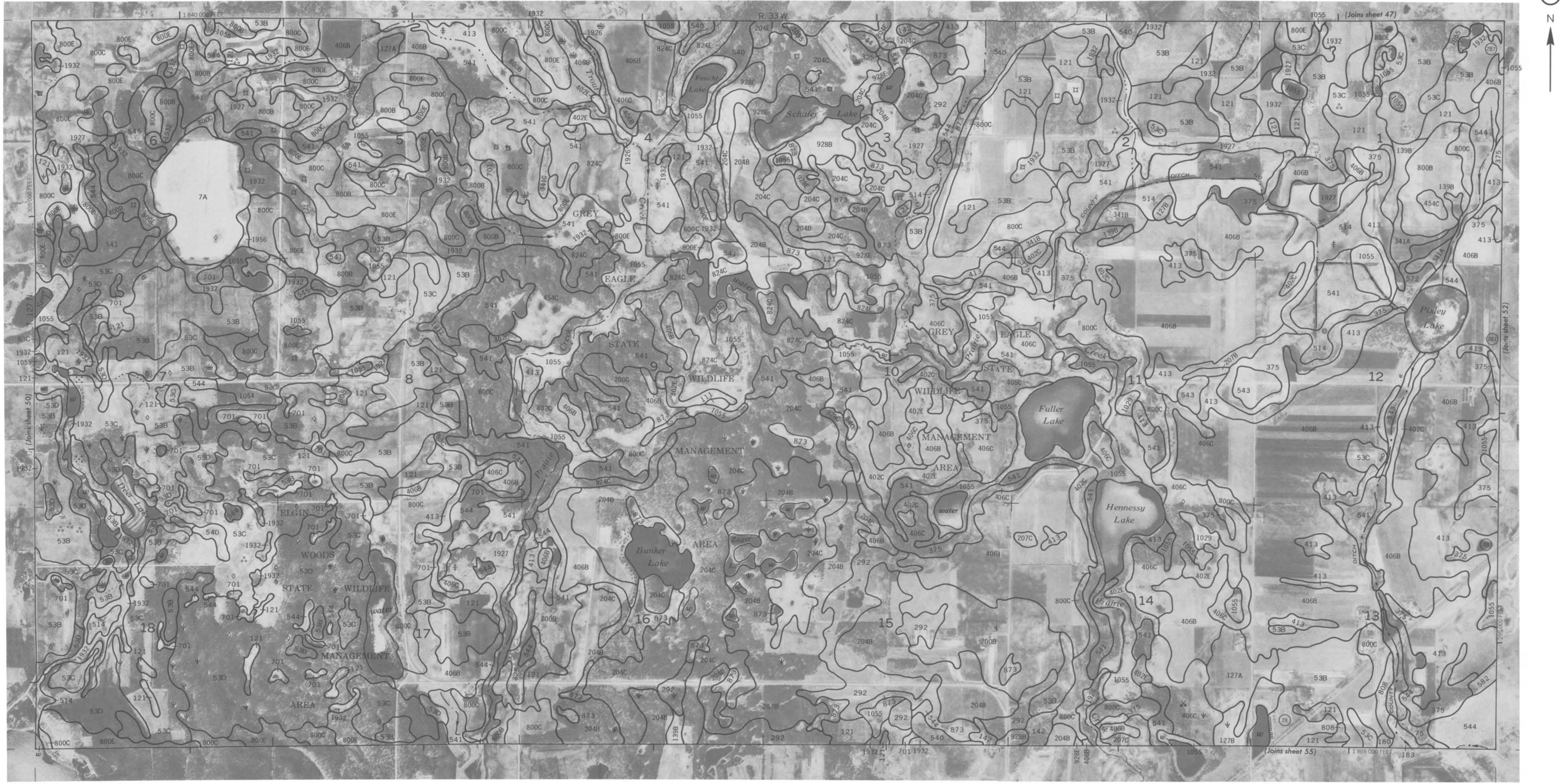
TODD COUNTY, MINNESOTA — SHEET NUMBER 49

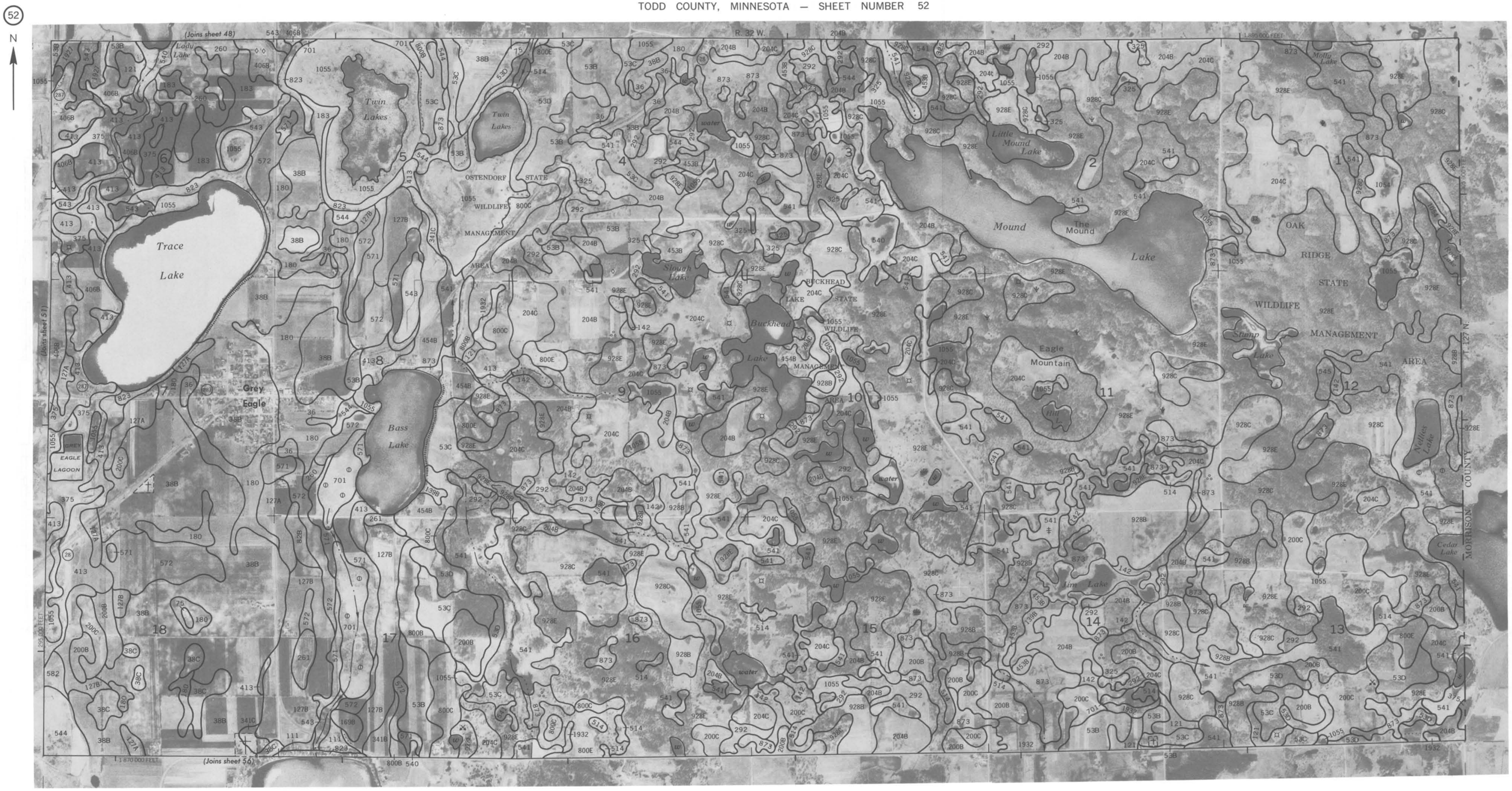

N
R. 35 W.
T. 127 N.
DOUGLAS COUNTY
(Joins sheet 45)
(Joins sheet 50)
(Joins sheet 53)
1 775 000 FEET
310 000 FEET
1 805 000 FEET
SOGGE WILDLIFE PRODUCTION AREA
SPOHN STATE WILDLIFE MANAGEMENT AREA
UNION STATE WILDLIFE MANAGEMENT AREA
WEST UNION
COUNTY DITCH
BURLINGTON NORTHERN
Sauk River
SAUK RIVER
Guernsey Lake
William Lake
Selinska Lake
water
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

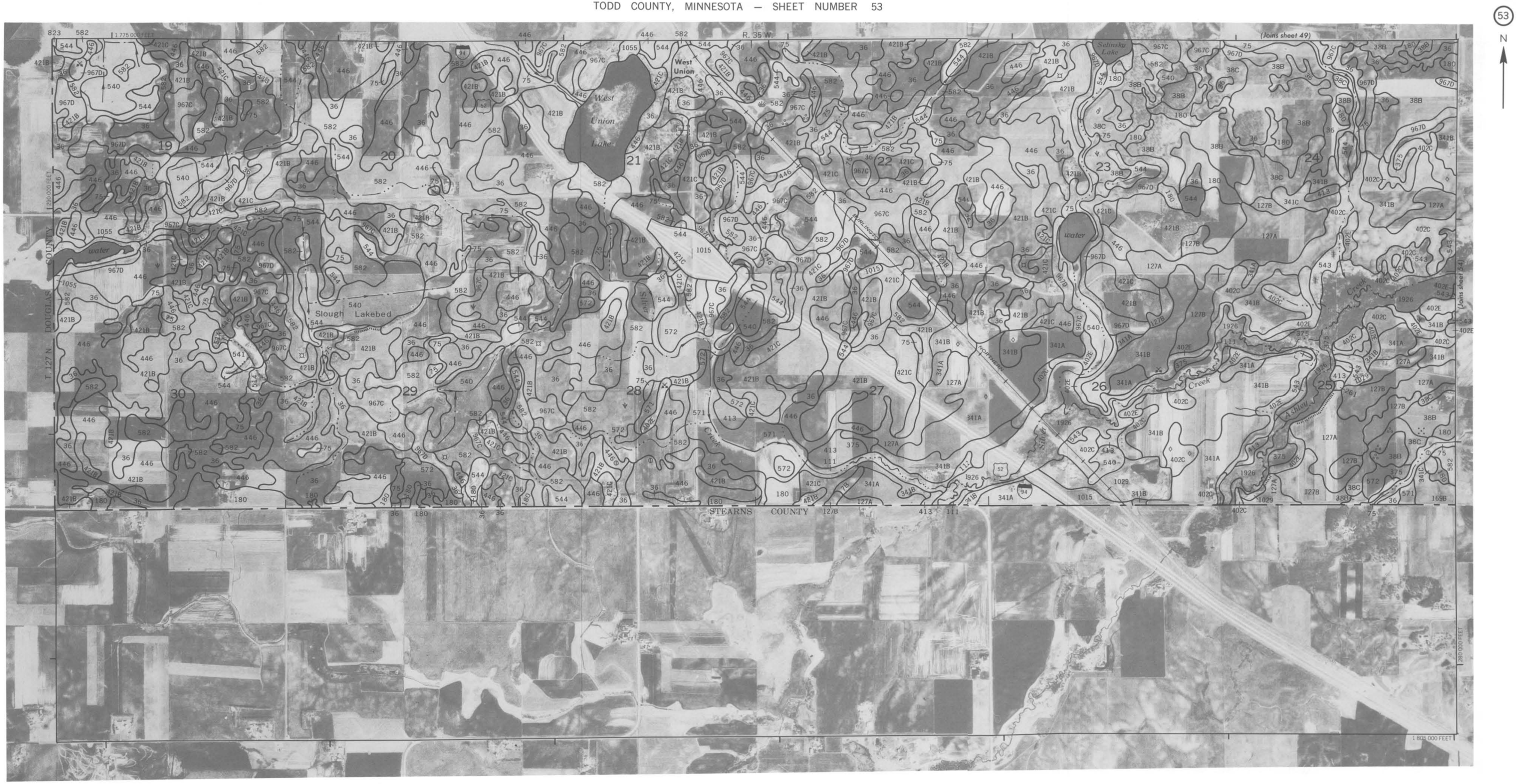
N

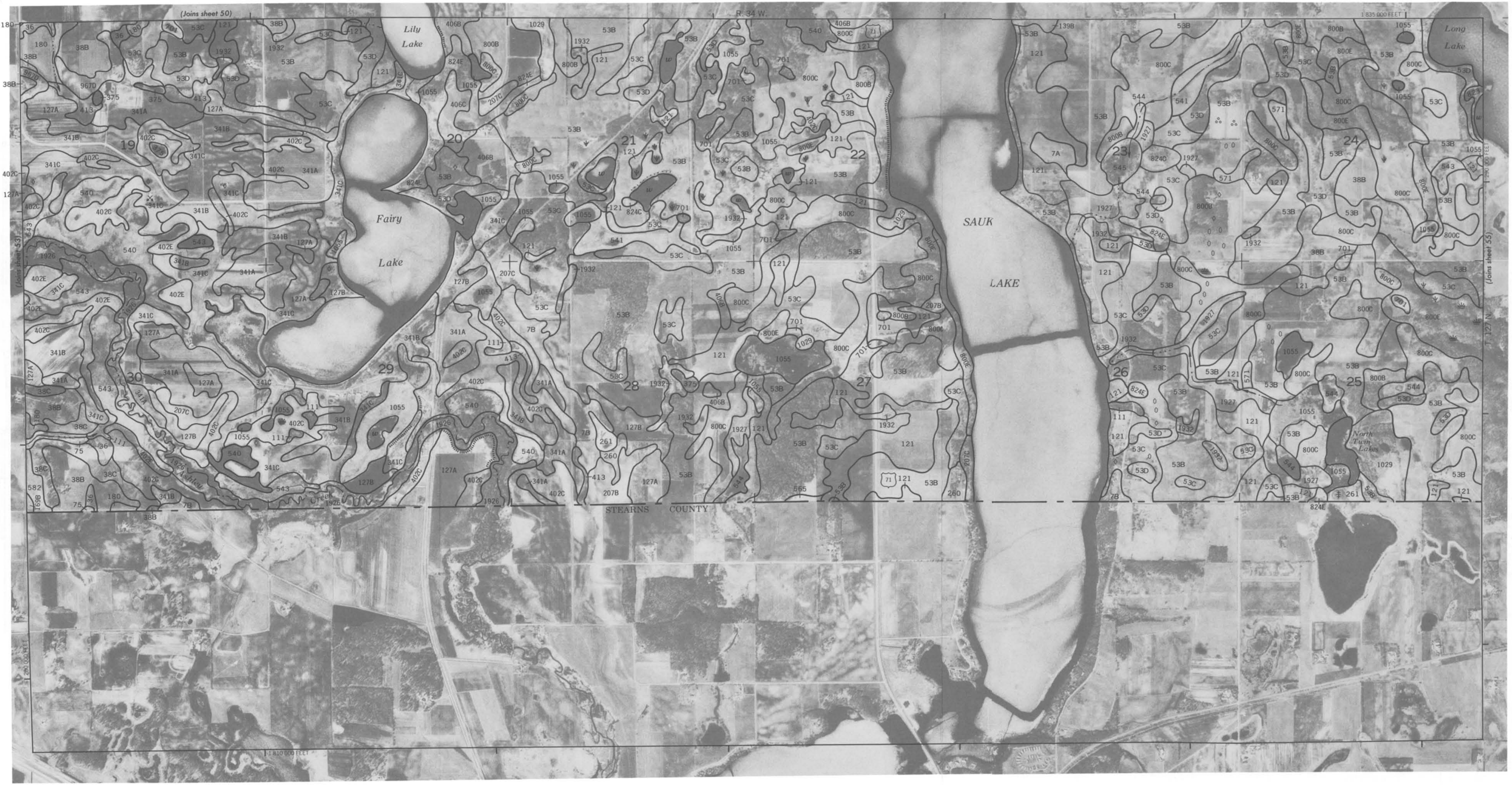

(Joins sheet 46)
R. 34 W.
1 835 000 FEET
(Joins sheet 49)
(Joins sheet 51)
(Joins sheet 54)
T. 127 N.
1 810 000 FEET
295 000 FEET
305 000 FEET
Sauk R.
Cedar Lake
Sauk River
Mud Lake
Long Lake
William Lake
Lily Lake
SAUK LAKE
Long Lake
water
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

(51)

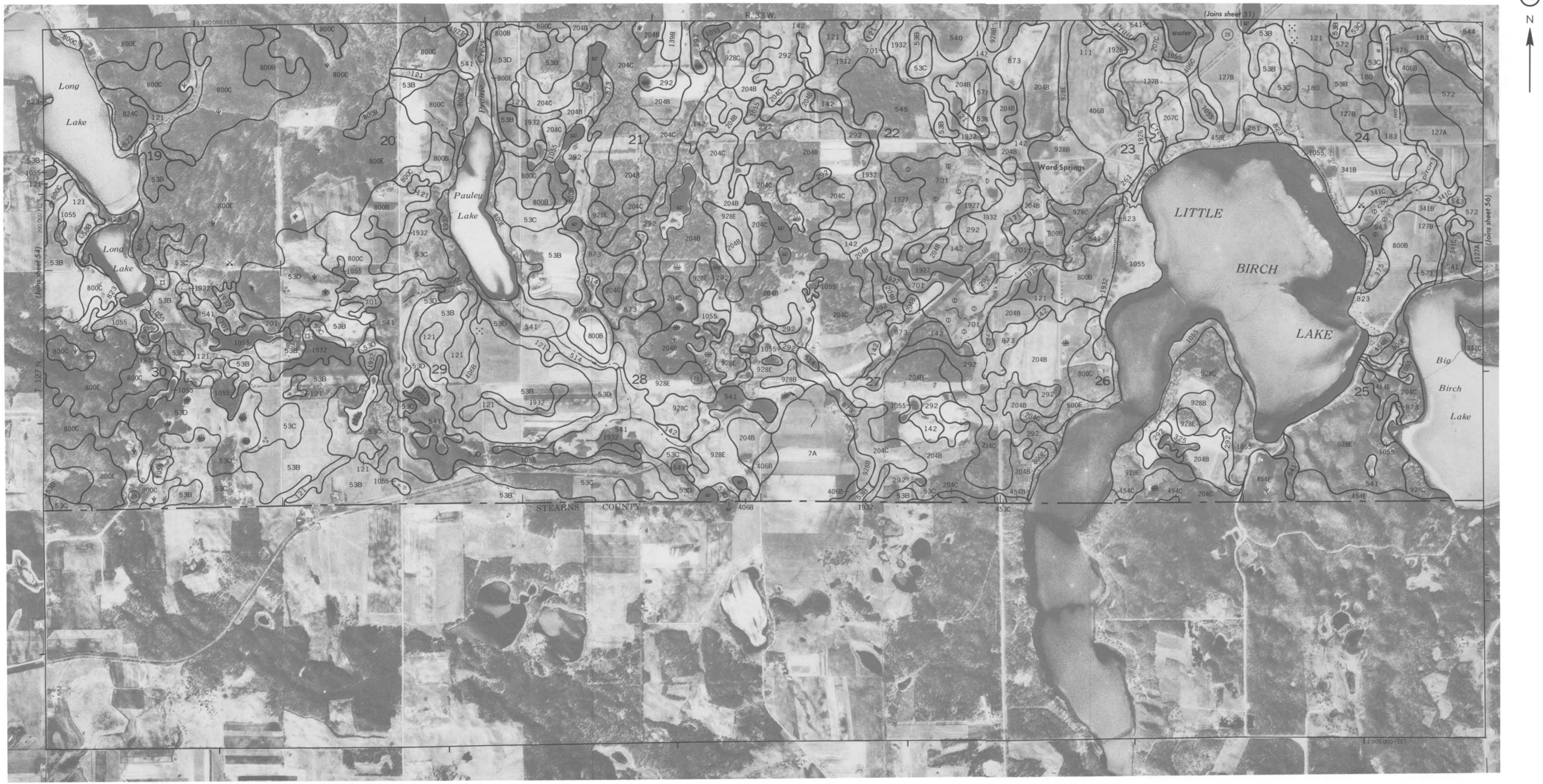

N
R. 33 W.
1 840 000 FEET
1 865 000 FEET
305 000 FEET
285 000 FEET
(Joins sheet 47)
(Joins sheet 50)
(Joins sheet 52)
(Joins sheet 55)
127 N.
Feucht Lake
Schafer Lake
Trout Creek
Pixley Lake
Fuller Lake
Hennessy Lake
Bunker Lake
Zager Lake
Dower Lake
GREY EAGLE STATE WILDLIFE MANAGEMENT AREA
ELGIN WOODS STATE WILDLIFE MANAGEMENT AREA
Prairie Creek
Eagle Creek
COUNTY DITCH
DITCH
water
7A
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

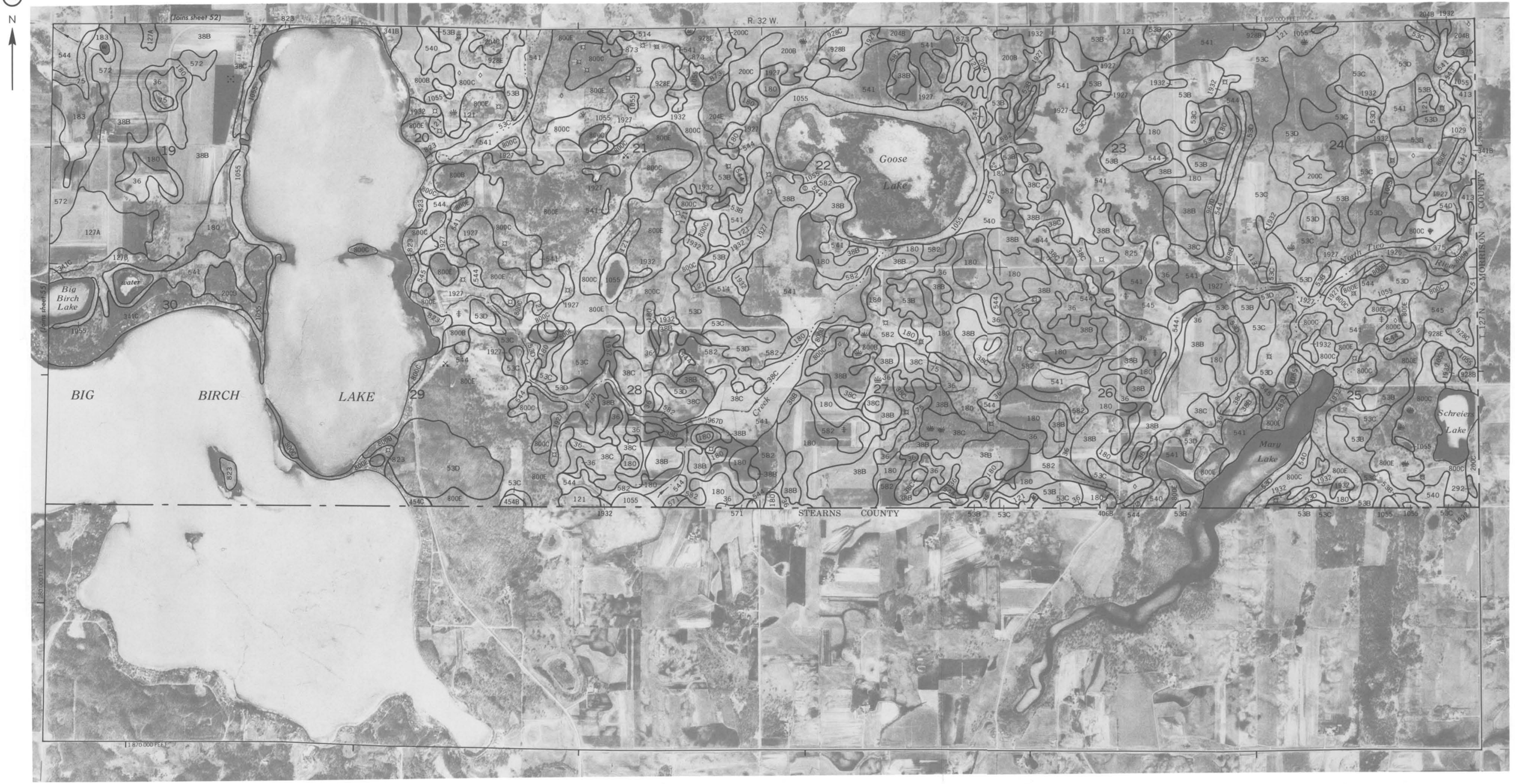

52
N
(Joins sheet 48)
R. 32 W.
1 895 000 FEET
Lady Lake
Twin Lakes
Twin Lakes
OSTENDORF STATE WILDLIFE MANAGEMENT AREA
Little Mound Lake
Molly Lake
Trace Lake
Slough Lake
BUCKHEAD STATE WILDLIFE MANAGEMENT AREA
Buckhead Lake
Mound Lake
The Mound
OAK RIDGE STATE WILDLIFE MANAGEMENT AREA
Rice Lake
Stump Lake
Eagle Mountain
Hill
Grey Eagle
GREY EAGLE LAGOON
Bass Lake
Nellies Lake
Cedar Lake
MORRISON COUNTY
T. 127 N.
Jim Lake
water
(Joins sheet 51)
295 000 FEET
1 870 000 FEET
(Joins sheet 56)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


53
N
(Joins sheet 49)
(Joins sheet 54)
R. 35 W.
T. 127 N.
DOUGLAS COUNTY
STEARNS COUNTY
1 775 000 FEET
1 805 000 FEET
280 000 FEET
West Union
West Union Lake
Selinsky Lake
water
Slough Lakebed
Silver Creek
Ashley Creek
Creek
BURLINGTON NORTHERN
94
52
19
20
21
22
23
24
25
26
27
28
29
30


N
(Joins sheet 50)
(Joins sheet 53)
(Joins sheet 55)
R. 34 W.
T. 127 N.
1 835 000 FEET
1 810 000 FEET
280 000 FEET
Lily Lake
Fairy Lake
SAUK LAKE
Long Lake
North Twin Lakes
Ashley Creek
STEARNS COUNTY
19
20
21
22
23
24
25
26
27
28
29
30
71

TODD COUNTY, MINNESOTA — SHEET NUMBER 55


N
R. 33 W.
T. 127 N.
1 840 000 FEET
290 000 FEET
1 865 000 FEET
(Joins sheet 51)
(Joins sheet 54)
(Joins sheet 56)
Long Lake
Long Lake
Pauley Lake
Prairie Creek
Ward Springs
LITTLE BIRCH LAKE
Big Birch Lake
water
County ditch
STEARNS COUNTY
19
20
21
22
23
24
25
26
27
28
29
30
800B
800C
800E
824C
823
121
53B
53C
53D
1055
1932
541
701
514
204B
204C
292
873
928B
928C
928E
142
1927
545
540
406B
127A
127B
341B
341C
543
572
180
183
454B
454C
454E
7A
325
111
1926
207C
261
375
544
75
571
139B
W


N
(Joins sheet 52)
R. 32 W.
1 895 000 FEET
(Joins sheet 55)
Big Birch Lake
water
BIG
BIRCH
LAKE
Goose Lake
Fish Creek
North Two River
Mary Lake
Schreiers Lake
MORRISON COUNTY
STEARNS COUNTY
T. 127 N.
1 870 000 FEET
285 000 FEET
19
20
21
22
23
24
25
26
27
28
29
30